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Editors
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Bonelli's Hawk-Eagle, *Hieraaetus fasciatus* (Vieillot)[1]

BY

S. M. Osman

11-D/10, Circular Road, Dehra Dun, U.P.

One evening as I was cycling along, thinking of the hot tea and thick slices of cake I would be enjoying once I got home to Dehra Dun, an eagle crossed the unfrequented track I had taken. A few short wing-beats very smoothly propelled it to a tree not more than a hundred yards from the place where I had abruptly come to a halt. A quick look through binoculars confirmed my suspicion. It was an eagle worthy of any falconer's mew.

The eagle had perched on the dead limb of an old mango tree. The way it looked around, its alert posture, and its choice of a commanding perch all indicated that it was hunting. At such a time, delay would be disastrous and the sooner I got my trap into position, I thought, the better would be my chances of capturing the eagle. I dropped the cycle where I stood, chose a spot to set the trap, and quickly went towards it with the trap in one hand and the live pigeon, used for luring hawks to captivity, in the other. Let me describe the trap. It is a strong

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[1] Accepted February 2, 1973.

net made from thin silk or nylon line. When properly fixed it stands about six feet wide, and about five feet high. On each side it is bracketed by wooden rods driven into the ground, and easy to erect since an iron spike is fixed to the bottom of each rod. The live pigeon is anchored to a peg also driven into the ground, in such a position that the net lies between the pigeon and the line of approach the hawk or eagle is likely to take.

The moment any bird of prey that flies to the bait hits the net, which falconers call the *dogaza,* the supporting wooden rods are dislodged and fall to the ground. There is not enough time for the hawk to back out of the collapsing net, and it finds itself shrouded in the folds of the *dogaza.* On very rare occasions, the hawk flies over the net and grabs the bait, but in all the years that I have been using the *dogaza,* this has happened only three or four times.

The feeling of anticipation a falconer experiences when about to catch a hawk is indescribable. It is a mixture of ineffable joy and tingling fear. It was with such anticipation that, after preparing the trap, I withdrew to the cover of some bushes to watch further developments. With bated breath, I watched the eagle's every move. It had spotted the pigeon behind the trap and was showing its interest in the bait by bobbing its head up and down, a sure sign that a bird of prey is about to home in on its target. In falcons, the lifting and lowering of the head preceding an attack is almost a continuous movement. The eagle had by now assumed a crouching posture, dwarfing it to almost half its normal size. It suddenly launched itself from the branch and flew fast towards the trap.

The painful suspense of such moments for a falconer cannot be exaggerated. He knows how keen is the eagle's sight, how likely it is to spot the net, or how a chance movement or sound may deflect its flight. He cannot relax until he has his prize in hand. Fortunately I was not to be disappointed this particular evening. The eagle crashed into the net that had been prepared to receive it, and when I had sprinted across I found it struggling in the shrouds of the fallen *dogaza.* It is one thing to examine some object from a distance through binoculars, and quite another to look at it at point-blank range. This was the first time I had seen such an eagle, and I was unable to label it correctly. All I could be sure of just then was that it was no ordinary hawk-eagle. My instinct told me that it was a rare bird and a great killer.

Instead of cycling home directly, I went first to a friend who was also a falconer. His name was Robin Lhockner. He had a lot of books about hawks, eagles and falcons, and I hoped to get my capture properly identified.

The first thing Robin said, when he saw me, was, 'Where are my binoculars?', and I then realized with horror that I had forgotten them when I sprinted across to the trapped eagle. I was so flabbergasted at my carelessness that I decided to change the topic at all costs and offered to give Robin the eagle. He promptly accepted the gift but reminded me that he needed the binoculars soon. I then hurried away, not home to tea and cake, but all the way I had just come, and found the blessed binoculars lying just where I had left them a couple of hours before. Next day I triumphantly returned them to Robin.

After comparing pictures of the various eagles in Robin's books, we came to the conclusion that this must be the famous Bonelli's eagle. We had read somewhere that hawks could be trained quickly if given camphor. It was said to be a widespread Indian method of subduing and training hawks because camphor, given in specific doses, would cause such a violent reaction that even the most headstrong bird would be shocked into obedience. The article went on to say that any hawk treated in this manner would forget its past life and freedom, and quickly learnt to look upon man as a benefactor always ready to help it with food. We gathered that a teaspoonful of camphor would be a safe dose for a bird the size of an eagle. I shall never forgive myself for trying the experiment, but like a fool I let curiosity get the better of my judgement.

The result was disastrous. Twenty minutes after the dose had been fed to the eagle, a very violent reaction similar to convulsions became apparent. Even after the bird had lost consciousness the muscles continued to twitch spasmodically. To feed the eagle was not possible; we only succeeded in pouring a small quantity of blood down its throat. Throughout the day, though kept under close observation, there was no improvement in its condition. I vainly tried to drain the crop by introducing a suction tube but all our attempts were unavailing and the eagle died on the second day.

In spite of this unhappy beginning I later found Bonelli's eagles easiest of all to train, soon losing their fear of man. I had many opportunities of examining them closely and will therefore attempt a fairly detailed description.

The upperparts are yellowish brown. The base of every feather, especially of those around the nape of the neck, is light yellow or almost white. Bonelli's eagle does not carry a crest like most of the ornate hawk-eagles throughout the world, but it has a few feathers which when raised are somewhat like a crest. The feathers of the mantle have dark brown shafts that contrast with the rest of the plumage, which is much lighter in colour. The upper portion of the tail is of a dark slate colour, becoming rather more grey lower down. Running across the tail are very dark slate-coloured bands, with narrower and less defined bands in between. The tip of the tail is a dirty livid white. Both primaries and secondaries are barred black and mottled all over. The wing-coverts have a dark brown central quill, and the greater wing-coverts are light brown. As the eagle gets older, with each successive moult there gradually appear traces of eyebrows similar to those seen in sparrow-hawks and goshawks. The eagle's cheeks are mostly of a cinnamon colour with dark streaks running through them. These streaks are actually shafts of feathers.

The feathers on the thigh are of a slightly darker shade than the rest of the underpart feathers. In immature birds that have been out of the nest no more than two or three months, the eyes are yellowish green, but with age the eyes turn to orange, and in some very old birds I have noticed them to be almost copper-red in colour. Normally a two-year-old bird will have golden brown eyes.

In immature birds the cere is usually dull yellow, sometimes whitish yellow. The feet are either dusty yellow or plain yellow but these colour-differences are not invariable, for the feet and the base of the beak are bound to be affected by the food the eagle has been getting, and also on the general health of any particular bird at a given time. In females the tail is about ten-and-a-half inches long. Each wing when fully spread measures about twenty inches.

Young birds as a rule have lighter plumage, the feathers along the nape of the neck being almost yellowish white.

I have come across this eagle in northern Afghanistan, in the Sind valley, and in parts of Baluchistan. My falconer friends tell me that these birds are found in many parts of southern Europe. The Booted Eagle of Europe (*Hieraaetus pennatus*) is a very close relative of Bonelli's (*Hieraaetus fasciatus fasciatus*). In his classical book on eagles Leslie Brown says that the birds of the genus *Hieraaetus* are quite plentiful in Africa. There are accounts of these birds by Turkish falconers who have seen them in Chinese Central Asia.

Bonelli's Eagle is met with in most of the northern provinces of Afghanistan and in some parts of Iran also. In the *Baz Nama a Nasarie* the author tells us how he once caught an eagle which he later trained, and was able to hunt Chukor Partridge with it. From the description I am sure it must have been a Bonelli's Eagle. In the *Baz Nama,* that famous treatise on falconry, Bonelli's Eagle is referred to by the name *ukab-a-sena-baza* which roughly means 'the eagle with a hawk-like breast'. Here the author is referring to the spots that normally cover the area mentioned.

In India the eagle is often seen in the Himalayas up to a height of nine thousand feet. During winter it may be seen all over the Peninsula, even as far down as Kerala. Identification in flight is not very difficult. The salient features to be noticed are (*a*) elongated wing-tips, and comparatively narrow secondaries, (*b*) flight much bolder and faster than that of any other hawk-eagle. There is some resemblance to an osprey, though there are colour differences and Bonelli's Eagle has a longer tail.

Nest-building begins as early as December in the Doon valley. Generally speaking, eggs are hatched in April. The nest is usually big, and mostly found two-thirds up some lofty tree on the bank of a river. Once I saw a huge nest built on a cliff. Twigs, lined with leaves, form the nest. It is bulky, and not very pretty, yet it manages to escape detection, and a casual observer will only notice a nest when he sees the eagle enter or leave it. In the western Doon in the hills along the river Jumna, I came across two nests. In one I found eggs of a dirty white colour, streaked with dark brown spots. In the other nest I saw an eaglet that could only have been a few days old, for its whole body was covered with white down.

Bonelli's Eagle is bold and energetic. It is extremely active and feeds much on partridges, grouse, sometimes pigeons but mostly wildfowl. Pheasants and peafowl are taken as well. The call is a screechy cry like that of a goshawk, only many times greater in volume.

My second Bonelli's Eagle was also acquired near Dehra Dun. I had gone for a long walk in country now ruined by indiscriminate limestone quarrying, and as I was watching the high peaks ablaze with glory in the last rays of the sun I became aware that the dark object on top of a tree a few hundred yards away must be an eagle. Without bothering to examine it through binoculars, I set about preparing the *dogaza* with a live pigeon for bait. As usual, after having pitched the net and bait, I withdrew to a flank to watch the proceedings. By this time the sun had sunk behind the Siwalik Hills and any detailed examination, even with the aid of binoculars, was impossible.

Just then a laughing bark drew my attention. I had often seen this crafty old fox in the same spot before, usually in the late evening on his way to raid a hen roost. Now it seemed that he was in great haste. When I turned again to look at the tree with the eagle on it I found it empty.

I stared at the net and soon realized that the trap had been sprung. Probably the fox had seen the pigeon and had begun to stalk it at the same time that the eagle decided to attack. On seeing the eagle approaching from the opposite direction the fox had turned and run for cover while the eagle, oblivious of the future that was in store for it, had sailed into the net.

It had become pretty dark by now and only a few flashes of white betrayed the fact that the eagle was struggling in the net. As fast as my legs could carry me I ran to the trap, but arrived too late to save the life of the faithful pigeon.

I got home at around eight that evening. My first object was to find a hood. I rummaged in vain in all the boxes I had, crammed with hoods of various sizes, but none would fit and I decided I should have to seal the eagle's eyes. This is not as painful an operation as the reader may imagine, though it does require a certain degree of skill and practice; also needed are the services of a helper to cast and hold the bird firmly.

I slipped a woollen sock over the eagle, my servant held it down gently but firmly, and in a few minutes the sealing operation was performed. Being confident that the eagle would remain quiet, I carefully slid off the woollen sock and deposited the eagle on a cushion kept on the ground for this purpose.

For a moment the eagle with sealed eyes stood sizing up the situation, then it flew straight at the light and the electric bulb exploded with a hollow bang. In the total darkness which ensued, there was no stopping the eagle. It kept on flying, blindly and in a rage, into strange objects. A heavy silver frame containing my great grandfather's picture was soon knocked off the wall and in the process of falling started a little avalanche of other family pictures. As befitted their subordinate status, the descendants fell with their progenitor. And all fell on to the sofa, where our cat had decided to take a nap.

With a terrific shriek of protest pussy leapt down, disturbing Dinky, our fox-terrier. Immediately there began a pitched battle between dog and cat. While this land engagement was in full swing, the air arm was not idle. It was again and again crashing into chandeliers, old china, and other objects that were foolish enough to get in its way. At last it flew into one of the curtains which mercifully came down, rod and all, on top of it.

In the meanwhile someone had opened the dining-room door and a goodish amount of light was coming through. I immediately attacked the heap of fury that lay helpless in the curtain and without much difficulty obtained a good hold, though in the process the eagle deeply scratched my hands.

The eagle was to give me some more anxious moments that night. At about two in the morning I got out of bed to pay a visit to the mews where the eagle had been left on a perch to roost for the night. Shivering with cold I crept to the mews, which in fact was an outhouse converted into a hawk-house, and was horrified to see that the door, which I had bolted from the outside before going to bed, was now gaping wide open.

When I got inside I found the eagle had vanished, but as I was wondering what could have happened I heard footsteps approaching. It was my father, who had been out with the eagle on his fist in the frosty morning air. This is a part of the training, gradually to wear down the eagle's resistance by keeping it from rest.

Most of the next day was spent in carrying the eagle about and in preparing a hood for it. When it was ready the eagle's eyes were unsealed and the hood clamped on. Round about eleven in the morning, feeding was attempted. The eagle showed no interest but by alternately pressing its claws, and rubbing pigeon meat on its beak, it began to peck, lowering its head to pull at the meat that was being offered. Though blindfolded, it managed to stow away almost half a cropful before we restrained it from having any more.

At about nine o'clock the same evening, we took the eagle to a dimly lighted room, and there gently slipped off the hood. The only source of illumination was a lantern, placed in one corner of the room and burning very low. I sat near the lantern, with my father a little distance away. In accordance with his signals I gently twisted the thumbscrew of the lantern, to raise the wick in the lamp very slightly. Gradually we increased the light in the room till the objects were well defined. The eagle seemed to accept their presence and showed no signs of agitation.

Now and again my father very gently stroked the eagle with a feather. The feather (which was in fact the primary quill of a pigeon) was drawn across its chest and, though the eagle did not positively enjoy such treatment, it did not mind it very much either. By now the lantern wick had been fully raised and the electric light switched on as well. All our attention was fully concentrated on the eagle and we watched it with hopeful expectation. For a little while we remained quite motionless, then very slowly at first, and without any jerky movement, the stroking was resumed. The eagle did not seem to mind much, for it just sat there looking from one of us to the other. When a piece of meat was held on the index finger and very slowly offered, to our surprise the eagle picked it up and swallowed it.

I very slowly got up from my chair and unhurriedly walked over to another one close by. The eagle watched me and did not attempt to fly off the fist. We then started speaking in hushed tones, so as to get the eagle accustomed to the human voice. The eagle did not mind this either and we were encouraged to raise our voices till we were soon speaking to each other as loudly as in ordinary conversation. The eagle bated a couple of times, but the fact that it climbed back to its perch on the gloved fist after bating was a clear indication that it was behaving very well. I began to think that it would soon be in flying order.

We retired to bed at about one in the morning. I was up again by five and the first light of the sun found me pacing the garden with the eagle on my fist. It had responded so well to an almost non-stop training programme of handling that I did not expect any adverse effect when I unhooded it again. But daylight, free vision, and an excellent prospect of trees all round was enough to make the eagle yearn for its lost freedom. Without any warning it became a raging lunatic. It bated again and again, till at last it hung exhausted from my fist. In vain did I try to help it back to a sitting posture. It simply refused to sit up properly, even after being hooded. No matter how hard I tried, the eagle continued to roll off my fist.

I had blundered. I ought not to have unhooded the eagle in broad daylight at this early training stage. According to the rules I should have punched two small holes in the hood in front of the eagle's eyes, permitting a very restricted field of view. Then every day these holes would have been enlarged, until the eagle enjoyed about eighty per cent visibility. Only then could the hood be safely removed. In my anxiety to accelerate the process of training, I had foolishly thrown caution to the winds.

Now that the mischief had been done, immediate steps to check any further bating would have to be taken. Every time a newly-caught hawk bates, it becomes excited. The excitement grows progressively with subsequent bates till a stage is reached when it is beyond all help. Hooding had been tried, and had failed. More drastic action was needed, so I put the eagle under the shower and doused it with water. After this it sat on the perch with drooping head, hooded and wet to the skin. This was better than hanging upside-down by the jesses.

After the eagle had remained on the perch for some time, all damp and forlorn, I attempted to feed it, but all my efforts having failed. I resorted to force-feeding in the afternoon of the same day. Under such circumstances it is imperative to keep the eagle well fed, for on an empty stomach the shock of handling can prove disastrous to a bird newly caught and undergoing training. Until late at night it was carried about on the fist and unhooded for extremely short periods. Next morning, on the third day of the eagle's captivity, it was collected from the perch, hooded and taken out on to the lawn just before sunrise. When unhooded it did not betray any unusual signs of jumpiness, though it still remained completely indifferent to the food that was offered it at feeding time.

Force-feeding is not a satisfactory answer to the problem, for if continued the hawk or eagle usually starts disgorging the food thus given. Something else had to be done, and done very quickly. Since dead meat conveyed no meaning to the eagle, a crow was netted and tied to a peg near the unhooded eagle, then sitting on a bow perch on the lawn. The crow immediately attacked, and had I not intervened would surely have damaged the eagle's feathers severely. My plan had failed, and the crow had to be removed. Then I tried a live pigeon, which was understandably very disturbed to find itself so close to the eagle, and repeatedly attempted to fly away. But the eagle remained unmoved throughout the performance.

By now I had became absolutely desperate. As a last resort, I got a live rat from our neighbour, tied a strong bit of twine to one of its hind legs, and attached it to the same peg which held the crow and the pigeon. After ignoring Master Rat for about a minute, the eagle began to watch keenly as the rat settled down to nibbling the cord that lay between it and freedom. After a few minutes it gathered itself together and pounced, killing the rodent in a clean strike.

I was triumphant but had no intention of allowing the eagle to take a meal off the dead rat. Cautiously I offered a piece of meat, and while the eagle was busy grabbing this, I managed to pull the rat away and hide it behind me.

The crowning moment came when standing about a foot away, I displayed a piece of meat on my gloved fist, and the eagle jumped to the outstretched fist and started to peck at the food. Gradually I moved away until in a few moments the eagle was jumping to my fist a distance of more than five feet. My hands were trembling with excitement as I watched the eagle. Was all this possible, or was it some sort of a dream? Half an hour earlier the eagle had been a raging, rabid brute, not caring to eat, and only interested in trying to get away from the company of man. Now it sat up obediently taking the food offered to it. I need no longer harbour fears of not being able to complete my training programme.

That afternoon, on his way out hunting, my uncle dropped in, and at the same time Robin also arrived, on short leave from Belgaum where he was undergoing some special military training. So we all set out together, father with the eagle, my uncle with his goshawk, and Robin with his peregrine falcon Comet. I took the Irish Setter I had painstakingly trained. Only the goshawk was in flying condition and it was decided to try her at partridges. So far as the eagle was concerned, the idea was to keep up the training pressure. It was allowed to remain unhooded for short periods only, and the moment it showed signs of uneasiness, or a tendency to bate, the hood would be immediately clamped on again. It would once again be unhooded, when all signs of nervousness had disappeared. During one of the spells when the eagle was unhooded, it noticed the goshawk on my uncle's fist, and from then onwards, whenever the hood was off and the eagle close to the goshawk or Robin's peregrine, it would promptly bate at them. This was exceedingly good progress. Robin henceforth gave the eagle a wide berth and my uncle blamed it for his goshawk's shameful performance that day. Indeed no sensible hawk could be expected to have much appetite for hunting when it is itself the object of an eagle's attention.

To avoid any further disturbance of the hunting I took the eagle from my father, and set out for home. Robin came with me and was obliged to hood his falcon for she was terribly afraid with the eagle eyeing her the way it did, and excited almost to the point of going into a fit. I remembered how a short while ago, a crow had attacked this very eagle with impunity and how the harmless pigeon, so much relished by all birds of prey, had completely failed to attract its attention. Now the eagle was ready to tear a goshawk to pieces and eat a peregrine falcon.

When my father got home late that evening he told me how things had brightened up after the eagle had quit the scene. The goshawk had bagged a grey partridge and run a junglefowl to earth, though it had not been possible to flush it out again. It is very annoying to the falconer when heavy cover and a tired dog make flushing out an impossibility. Sometimes the quarry even seeks refuge in a disused rodent warren.

I tried to digest as much of the news as I could, but was already thinking of the future. How could I raise the money required to buy a nice pair of bells for my eagle? I remembered an elaborate pencil-sharpener given me by some well-meaning relative. It was just as good as new, and after a great deal of haggling, I managed to sell it for twelve rupees.

In those days, one could order bells to suit one's hawk or eagle from the hawk market at Amritsar. Eagle's bells were more expensive, because not many people took to training eagles. I ordered an extra large pair which cost me Rs. 5, at a time when a pair of peregrine bells could be picked up for a rupee.

Everything went according to plan during the next two days. At feeding time, a whistle was blown at regular intervals, and soon the eagle began to associate this sound with its food. Even when hooded it would become restless, and search for food when it heard the whistle. She (for the bird was a female) had also grown quite tame and could be called to the fist from twenty feet or more.

Up till now the eagle had never been called from a perch higher than my shoulder. It is always best to call a new hawk from the ground to the fist for then it will be flying to a higher perch, which normally birds of prey do not mind. If obliged to fly down, they are less likely to cooperate. At this stage of training all hawks are held on what is known as the creance. This is a long line attached to the leash of the hawk and held by the falconer, to enable him to restrain any straying from the course. I soon had my eagle flying from any distance and height without any hesitation, which was a fair indication that the creance was no longer required. I could throw her up on to the tallest tree in our compound and when called she would obediently fly down to my fist.

It was on the eighth day after the eagle had been captured that there occurred an incident, which though it happened more than thirty years ago, still makes me shiver to remember. I was visiting my uncle's house and was sitting with the eagle unhooded and on my fist. My uncle's one-year-old son began crawling towards me and I was encouraging him to try to stand up and take a few steps. As usual I had the eagle on my right fist. The child approached from the left, and tried to stand up by supporting himself against my leg. When his head was almost level with my knee the eagle attacked. I was a fraction of a second quicker in jerking up and away the fist that held the eagle. I shudder to think what would have been the result had the eagle been successful in her attack, for a child's soft bare head can offer little resistance to the grip of an eagle's powerful claws.

On the sixteenth day after its capture, the eagle took a live fowl in great style. It was in yarak, ready to hunt. When this condition has been attained it is advisable to fly the eagle or hawk at game as soon as possible. For two successive days we vainly tried to find suitable quarry in the vicinity. A couple of junglefowl were flushed, but the birds broke cover at awkward angles and a slip was not made. It has to be remembered that the first flight at game by any new hawk or eagle should be one hundred per cent successful. If not, a bird of prey may completely lose confidence in itself.

Therefore we called a council of war, and decided to go to Riawala by the next train, there to fly the eagle at peafowl. Riawala is in the Eastern Doon valley, and was then one of the best areas for hunting and shooting. Unfortunately all the beautiful forests that once stretched from the station right to the banks of the Ganga have been cut down, and all the game wiped out long ago.

At 7.30 in the evening we entrained at Dehra Dun and reached Riawala an hour later. We were a party of three—my father, myself and an old friend whom I will call G.

It was bitterly cold and we made for a hut where we saw a fire burning. It was occupied by a party of bullock-cart-drivers who hauled timber from the forest to the railway station. They welcomed us, and since there was lots of room inside the hut we decided to spend the night there. By a happy accident a pole was slung across the entire breadth of the hut, which would serve as a perch for the eagle. Beyond the pole were tethered a number of oxen, wearing sackcloth coats to protect them from the cold of the night. As I lay well wrapped up in my blanket on a bed of straw, I was amused to see by the light of the fire the eagle slice a mute far out which landed on one of the coats and made a white pattern like an exploding rocket, or some fiery-tailed comet. The mark of the eagle, I thought. Soon after, she fluffed out her feathers, pulled one leg up, turned as though to examine the pattern on the bullock's coat, then tucked her head beneath her feathers and went to sleep.

Before dawn we set off, Father carrying the eagle, I the shot-gun and our lunch, and G following with a few extras such as cups and a kettle. The sun had not yet risen and mists were rising from innumerable springs and gullies, lying round us and on the road as well like teased wool. Patches of hoar frost gave evidence of the drop in temperature during the night.

We had marched nearly three miles when the first rays of the sun bathed the crests of the tallest trees in a flood of orange light. Another five miles brought us to our hunting ground, the famous Virbather shooting grounds on the western banks of Gangajee. The country was one big undulating pampas-covered field, stretching for many miles. Giant cottonwood trees grew at intervals all over this savannah type of country, and in the depressions one would find a luxuriant growth of bramble bushes, with as often as not a tiny spring of crystal-clear water running in the middle. In these depressions, which looked like tiny oases, lived peafowl, junglefowl, many a sounder of pig, a rare tiger and even marsh deer, as well as the dainty little Chausinga antelope. This last antelope has now become extinct throughout the Doon valley.

We spread out and advanced towards a depression thickly overgrown with bushes, trees and brambles. I was sure there would be peafowl, and we had hardly gone twenty yards when with a shrill cry out flew three hens. My father unhooded the eagle, and cast her after the peahen closest to him. She made a bee line for the bushes growing on the rim of the hollow, flying almost over my head, with the eagle close behind and nearly underneath. This trick of chasing game and ultimately attacking the quarry from below is adopted by all the accipiters. As eagle and peahen were silhouetted against the blue of the sky at the edge of the depression, the eagle turned on her back and grabbed the quarry by the breast. Both came down in a big flutter of wings into a monstrous bramble patch.

I reached the top of the rise just in time to see the peahen break from the far end of the thicket and immediately take to the air. Swiftly I drew a bead on her and brought her down. We then went to rescus the eagle, which was hopelessly entangled in the thorny bramble. With her greater weight the peahen had managed to smash loose from the eagle's grip and get away, while the eagle's jesses had knotted round a twig. I had to cut a path into that veritable thicket of thorn with my hunting knife before I was able to free her. The first slip at game had not been as successful as we wished it to be. It was only a partial victory. Could we induce the eagle to believe that she had really made a kill? While Father and G stood with the eagle behind some bushes, I tied a long line to the dead peahen and hid her in some grass about twenty paces away. Then I hid and at a signal from my father, who stood with the unhooded eagle on his fist, began to pull the peahen into the open. As soon as the eagle saw her victim she launched herself and grabbed it. This sort of subterfuge works very well sometimes but it is not advisable to repeat it often.

After the eagle had tasted a little blood she was allowed to feather the quarry for a short while and then hooded. Later that day we hoped to give her another try.

Any falconer will tell you that the right time for hawks and other birds of prey to start soaring is the middle of the day. We did not wish the eagle to do any soaring so she had to remain grounded for the afternoon. But soon after we headed for a narrow strip of land bordering the western bank of the river. Opposite this, the Ganga had split into innumerable channels, most of which could be easily crossed. There were clumps of khair trees on many of the islands and as we reached the bank of the main stream a peacock flew out of a little bush and headed straight for the mosaic of islands beyond.

He was a monster, with a magnificent tail. By the time my father had managed to slip the hood from the eagle's head and cast her, the peacock had gained a considerable distance and was making for one of the islands. The eagle rose sharply above the khair trees when it reached the island on which the peacock had taken refuge, and for a moment I thought she was starting to soar. However, she flew steadily on till she gained the centre of the island, and then dropped like a stone and disappeared in the dense jungle. A piercing scream from the peacock soon followed, and we all rushed towards the spot from which it had come. G and I were a bit delayed by tumbling one after the other into a pit which someone had been digging for porcupine. Father arrived first. When he got there he found the eagle, looking very small, bothering the already dead peacock.

We allowed her to feather the kill for a while, and then cut out and gave her the liver. We also added half a pigeon to the eagle's menu that evening, for she had started to earn her keep.

This had been very good going. The eagle had registered a kill within nineteen days of its capture, the shortest time in all my experience. Normally eagles trapped as passengers, or adult birds obtained from dealers, require at least two to three months of gruelling work before they are ready for the hunting field. My falconer friends agree such a short training period is very rare. Probably my eagle was exceptionally intelligent.

I was very happy with her, and we used to go out almost every day after hares and junglefowl. She was always very keen, never showing any lack of interest no matter how much she had been fed the day before. Soon we found ourselves in the middle of March, the time some birds get excited with ideas of nest-building and rearing a family. Under normal conditions, a bird of the hawk tribe always mounts guard over the spot where it has run game into cover, so that the falconer can come along and flush the game that has taken refuge in the thicket, giving the eagle, or hawk, another chance of flying down the quarry. Falcons immediately start soaring over the spot where they have run a quarry to earth, but when hawks and eagles soar, it indicates the influence of the mating instinct. My eagle had now begun soaring on two consecutive occasions after her quarry had taken refuge in some bush.

For more than a week I was not able to devote more than half an hour a day to my eagle, being fully occupied with training a Shahin falcon, a tiercel, that I had captured. Then a friend came along who wanted to see the eagle in action, and pressed me to fly her at game. In the area where the eagle had been first netted we soon put up a hare and cast the eagle after it. It was a thrilling chase but at the last moment the hare twisted sideways and the eagle struck only the ground. She rose slowly, much disappointed, and began to soar. Having foolishly forgotten to bring along the lure, and being without any live bait with which to coax her back to earth, I could only watch her mount till she became a mere speck against a silvery patch of clouds in the background. For the next two or three days I walked mile upon endless mile, swinging the lure and blowing the whistle, vainly seeking her. But she must have left for the hills, and I hope that there she met her match, built a home, and reared a family.

Many years passed before I again came across a Bonelli's eagle. I had been marching through the Eastern Doon jungle, and was in Motichur block where the old Hardwar-Rishikesh cart road climbs steeply to enter the Government forest. Here there are giant trees of a kind to be seen nowhere else in the Doon valley, towering to a height of more than two hundred feet, and through these trees I saw an eagle fly, heading towards the open grassland beyond.

Snatching up the trap and my binoculars, I immediately followed in the general direction the eagle had taken. A couple of hundred yards beyond the rim of the cliff, where the trees grew less densely, I halted to scan some likely trees, but there being no eagle in sight I proceeded further and further in the direction I had seen the eagle fly, till I was standing on the edge of a huge grassy plot. Here I could see an object looking like an eagle perched on a solitary cottonwood tree some distance away, and with the binoculars it was easy to identify.

I set the *dogaza* at a place clearly visible from the eagle's point of vantage and fastened a live partridge which I had with me behind the net for bait. Then I withdrew to take cover and watch developments. Almost at once the eagle flew down and was caught in the meshes of the net but before I could reach it it had ripped the net to shreds and was flying away with the dead partridge dangling from its claws. Even today I do not know how it happened, for I had spun the net with thin, strong cord. Anyway I had lost my third Bonelli's eagle.

For me, capturing an eagle, or any other bird of prey, is more than half the fun. I do not mean taking an eagle from the nest, or trapping a parent when it is engaged in raising a family, for in such cases capture is more or less a foregone conclusion. I prefer to go out into the country at a time when the eagles, or hawks, or whatever I am after, are not handicapped by nesting activities. I may have to tramp for miles, day after day, before meeting the object of my desires. Then to set a trap, and persuade a recalcitrant monarch of the air to fly into the net requires not only skill and experience but also some element of luck. It gives me great satisfaction to catch a bird this way.

I will now describe yet another failure. I was raking the countryside around Danda in quest of birds of prey, in a maze of deep overgrown ravines, interspersed with groves and a few fields, and with Nalapani Hill crowned with the once famous Kalanga fortress rising sharply to the east.

Soon I was attracted by a congregation of crows in a distant mango grove. They might, I thought, be mobbing an owl, an eagle, a hawk, a falcon, or even a harmless cuckoo. Their object might also be a stone marten, a jungle cat or even a dead crow caught in a branch. There was absolutely no harm in investigating, for inquisitiveness is the falconer's main attribute, so I cut across and found a whole pack of black devils concentrating their attack on an object that looked like an eagle, sitting in the middle of a massive old mango. Though lighting conditions were not very favourable, through binoculars I was soon able to identify an old acquaintance. It was an immature Bonelli's eagle. There was no time to lose, and I looked around for a favourable spot to pitch the net.

The choice of ground for a trap is very important. The trap and bait must be in full view of the bird that is intended to be caught, broadside on. The background should be such that it does not throw the net and its meshes into contrast with the surroundings, for with the sky as a backdrop every mesh on the net would be finely etched, and the hawk would probably take fright. On the other hand, the sharp outline of the meshes is well camouflaged when the net is spread against a green and dappled background of bushes, and a hawk in a hurry to pick up its dinner will hardly notice it.

A live bait must be secured behind the trap, at a suitable distance. If fastened too close the bait may work its way into the net and bring down the trap intended for the hawk, but if too far away the hawk may be able to grab the bait without having to go dangerously near the net. Also, the line on which the bait is held be long enough to allow it to flutter about, and give the hawk the impression that some easy prey is available for capture; but if the line is too long the bait may get caught in the net. Then the falconer must choose bait appropriate for his purpose: a wild bird of prey is not likely to fly down to something it has never before seized. It is essential to make a thorough study of the feeding habits and sex of the bird of prey one is trying to capture.

It is well known that in birds of prey, the female of the species is bigger than the male, and also stronger. The disparity is not so obvious where eagles are concerned, and in the wild state, both male and female birds can be seen pulling down game of the same weight. But for hawks and falcons the difference in size must always be taken into account. Similarly, when he has trained his hawk or falcon, the falconer must know the sort of game to hunt as well as the country in which to look for it.

For a Bonelli's eagle the best bait would have been a partridge, for with partridges it is possible to bag not only eagles, but any bird of prey, from pretty little sparrow-hawks to powerful goshawks. But Bonelli's eagle is also very fond of the blue rock pigeon, which was the only bait I had to offer that day. Having chosen my site, and set the trap, I retired to a flank to wait and watch. I had the eagle sharply in focus as it took off and flew towards the trap, but to my horror it suddenly swerved out of my field of vision, and when I lowered the binoculars I was only just in time to see it rising from behind a bush some distance from the net, with the pigeon I had tied behind my trap dangling from its claws.

It took me some time to figure out what had happened. It was a wet, rainy day and I had used an old eight-inch screwdriver as a peg to anchor the pigeon. The screwdriver was strong, and so was the bootlace used to tie the pigeon to it. I had pushed the screwdriver deep enough into the soil to make it firm and steady under normal conditions, but in soft wet soil it should have been hammered in a few inches more. When it saw the eagle making for it, the pigeon had made a terrific struggle to smash loose from its mooring and had managed to dislodge the screwdriver from the soft soil. It had escaped to the nearest bush, but had once again run into bad luck. The screwdriver had got entangled in a bramble, so that the pigeon was held dangling by the bootlace. Then the eagle had struck, carrying off the screwdriver, a bit of the treacherous branch and the game little blue rock all together.

Bonelli's Eagle has been prized by falconers all over the world for its boldness and bravery. It is comparatively easy to train and when trained loses all fear of man. Its long primaries and short secondaries fit it for soaring, and I have on a number of occasions seen it dive from the sky to capture game on the wing. Normally it thrives on the border lands where the forests merge into open country, and though it is not as fast as the crested hawk-eagles over short distances it will follow game for much greater distances and does not seem to be discouraged by a long chase.

There is just one more aspect I would like to mention, for the sake of my falconer friends. When training Bonelli's Eagle, I noticed that it was not at all punctual in disgorging its cast very day early in the morning. A cast is a tight pellet of feathers thrown up each day by hawks and falcons, the remains of the previous day's meal. Unlike meat and bones, feathers cannot be digested and have to be ejected in this form; it is nature's way of cleaning up the inside of a bird of prey. If the cast is not thrown out every day at sunrise it indicates that the eagle is not keen to hunt.

The language of falconry is often confusing, and while a cast or casting is something thrown up from the crop the same word 'casting' is applied to any purgative dose given to a hawk. The fur and feathers given to a hawk with his food is called a casting, and it is in these castings the medicines are administered. Hawks are regularly dewormed, and are sometimes sick or in need of a tonic. If they are not ejecting their daily pellet regularly, the meat should be soaked in luke-warm water mixed with isabghul. Other ways to stimulate regular ejection are to mix crushed bird-bones with the meat or to force-feed two or three tiny pebbles wrapped in cotton-wool or a chunk of meat. Normally however hawks thrive on a diet of dead birds and rodents, and if only mutton is available some feathers or fur should always be given with it.

Indian Mammals on Texas Rangelands[1]

BY

ERNEST D. ABLES[2] AND CHARLES W. RAMSEY[3]

(*With two text-figures*)

Seven species of Indian ungulates have been introduced onto rangelands in Texas. At least four of these species are successfully established with population in excess of 4,000 animals. Similarities and contrasts between the Texas and Indian habitats are noted and the role of exotics on Texas rangelands is discussed.

INTRODUCTION

Within the State of Texas at least 26 species of non-native ungulates, exclusive of domestic livestock, have been introduced by landowners. Most of these exotics exist as free-ranging herds on private ranches which vary in size from a few hundred acres to more than 100,000 acres. In some instances individuals of a species have escaped and spread over large geographic areas. Most, however, are confined within individual ranches by 7-8 foot high game-proof fences.

United States Government health regulations prohibit direct importation and release of wild ruminants and swine from countries where foot-and-mouth disease or rinderpest is declared to exist. However, animals with proper health inspections and clearance may be imported and placed under permanent consignment to specifically approved zoological gardens where the animals must spend the remainder of their lives (Smith 1968). The progeny of these captive animals can be purchased and released on private lands in Texas and in some other states (Craighead & Dasmann 1966). Such releases have

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been made by landowners since as early as 1924 (Sheffield *et al.* 1971). As range herds produced surplus animals and the demand for animals to stock other ranches grew, the activity of supplying exotics shifted from zoos to private ranches. Presently the supplying of breeding stock has become a business for some ranches.

Most early stocking of exotics was motivated by the allure of new and different game species. However, in recent years the economic possibilities of game ranching to supply trophy hunting to paying sportsmen has promoted new releases. As of 1971, more than 300 ranches in Texas had one or more species of non-native big game.

INDIAN SPECIES PRESENT

Places of origin for exotics in Texas include Africa, Asia, Europe, and the Mediterranean region. The most numerous and widespread species, excluding wild sheep (*Ovis* spp.), are native to the Indian subcontinent. Seven species of Indian origin exist on ranches throughout the State (Table 1). Estimated numbers are based on a 1963 survey by Ramsey (1969) and modified by data collected since that time. A current survey would surely show larger numbers and wider distribution within the state.

TABLE 1

SPECIES AND NUMBERS OF INDIAN UNGULATES THAT OCCUR IN TEXAS

Chital (*Axis axis*)	> 10,000
Blackbuck antelope (*Antilope cervicapra*)	> 4,000
Wild Boar (*Sus scrofa*)	> 10,000
Nilgai antelope (*Boselaphus tragocamelus*)	> 4,500
Red deer (*Cervus elaphus*)	> 300
Sambar (*Cervus unicolor*)	> 100
Barasingha (*Cervus duvauceli*)	> 50

The animal nomenclature follows that of Prater (1965). Subspecies present are generally not known, or have been obscured by interbreeding. Easily recognized morphological differences exist among certain species, but it is uncertain whether or not these are genotypic or phenotypic variations. Most chital fit the general description of *Axis axis axis*, however, some ranches have a form smaller and stockier in size, and with shorter antlers. These animals more closely resemble *Axis axis ceylonensis*. The red deer or stag and the wild boar are advertised in hunting brochures as being European in origin. However, some zoo stock came from India or the Himalayan region, and doubtlessly have supplied some of the animals stocked on Texas ranches.

DISTRIBUTION AND HABITAT IN TEXAS

Areas in the state which contain the greatest numbers of exotics are the Edwards Plateau, the South Texas Plains, and the Gulf Prairies and Marshes (Fig. 1). Reasons for this pattern of distribution are partially cultural and partially ecological. The largest number of species and the greatest numbers of animals are in the Edwards Plateau. This region is devoted mainly to ranching enterprises: cattle, sheep, and goats. It is also the area containing the greatest numbers of white-tailed deer (*Odocoileus virginiana*). In recent years the economic return from sheep and goats has greatly declined. Landowners have consequently sought means of supplementing ranch income by stocking exotic game and charging sportsmen for the privilege of hunting.

Ecologically, the regions of Texas with the largest numbers of exotics are very similar to their native ranges in India. The area of Texas containing most exotics is between 26° and 31° N. latitude, and lies

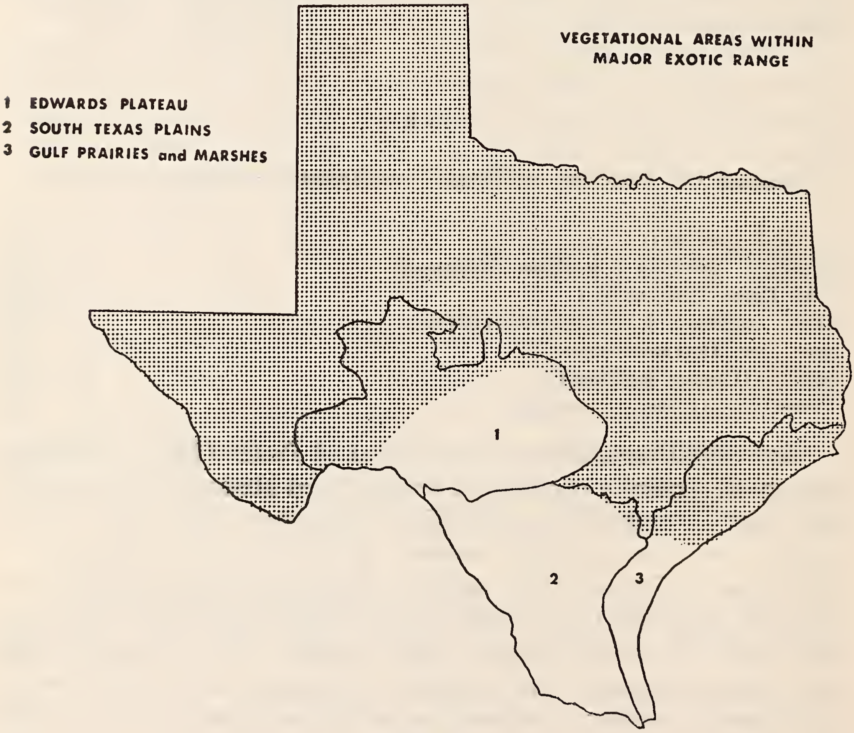
VEGETATIONAL AREAS WITHIN MAJOR EXOTIC RANGE
1 EDWARDS PLATEAU
2 SOUTH TEXAS PLAINS
3 GULF PRAIRIES and MARSHES
1
2
3

Fig. 1

within the latitudinal ranges of India, approximately 8°–33° N. latitude. Annual patterns of temperature and precipitation are similar in both regions with extremes in precipitation in India being greater (Fig. 2). Temperatures in the northern Edwards Plateau sometimes drop below 0° F. during the winter, while in some years temperatures do not fall below 32° F. in the extreme southern tip of Texas.

The Edwards Plateau is an area of some 24 million acres characterized by rough, stony hills dissected by several river systems. Elevations vary from 1,200 to more than 3,000 feet. Soils are shallow and underlain primarily by limestone. The climax vegetation is grassland and open savanna. Overgrazing by domestic livestock has depleted the grass cover and has resulted in an increase of woody plants such as mesquite (*Prosopis juliflora*), live oak (*Quercus virginiana*), shinnery oaks (*Quercus* spp.), and junipers (*Juniperus* spp.).

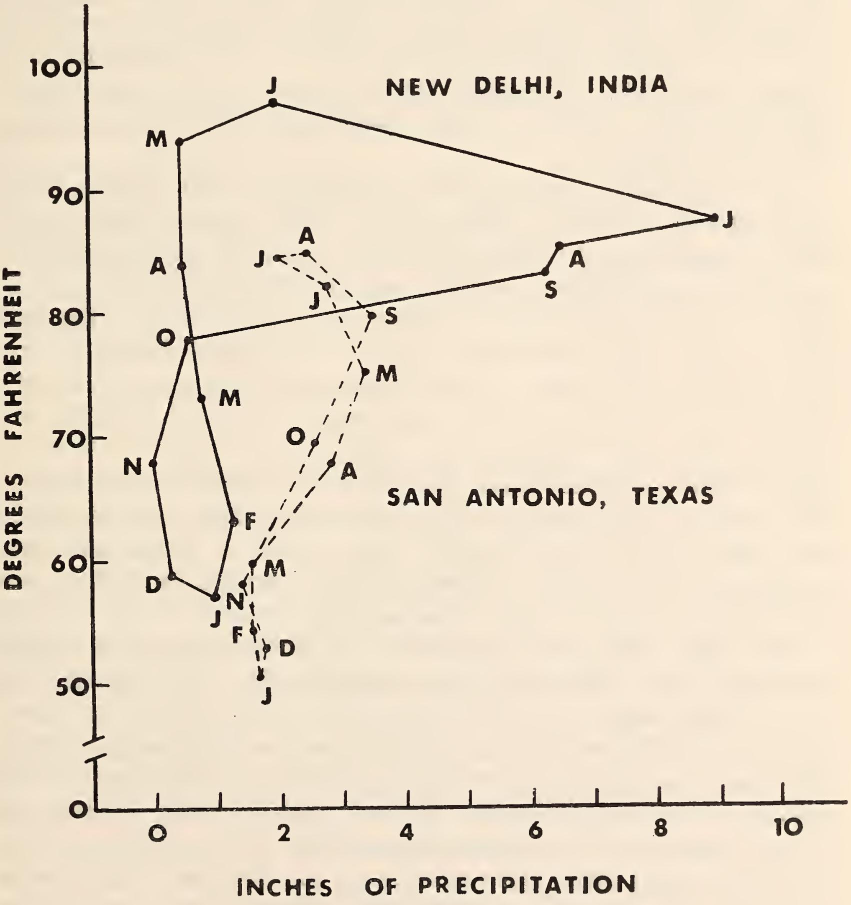

Fig. 2

The South Texas Plains and the Gulf Prairies and Marshes together comprise an area of almost 30 million acres. This region of flat to rolling topography originally supported a climax grassland. Reduced numbers of fires and overgrazing by livestock have vastly altered the plant community until now scrub woody vegetation is the predominant growth form. Invading woody species include mesquite, live oak, prickly pear cacti (*Opuntia* spp.) and several species of *Acacia*. Land use practices are similar to those of the Edwards Plateau though farming is more intensive on the Coastal Plains.

The wild boar is perhaps the most numerous and widespread species, but because of its secretive behaviour it is difficult to accurately estimate their population. This cosmopolitian species quickly adapted and successfully established itself in the wild. In several regions the animals have mated with feral domestic swine. The resultant wild hog is not readily accepted by landowners particularly in the Edwards Plateau where they cause damage to net-wire fencing and occasional depredation of young sheep and goats. They are also accused of competing for food with native game and destruction of turkey (*Meleagris gallopavo*) nests. However, little documented information on their true role is recorded.

The adaptability of spotted deer is apparent in that it has a wider distribution of established herds than any other species. There are at least two populations of chital that number more than 1000 individuals. In addition, an unknown number have become established as free-ranging wild animals outside of game-proof fences in the Edwards Plateau. One large population exists on the Coastal Plains in predominately low (1-6 feet) live oak interspersed with open grasslands. However, the majority are in the more rugged, drier Edwards Plateau. Spillett (1966, 1968) described the habitat of the chital in India as primarily open deciduous forest that sometimes graded into thorn scrub. There was an indication in the drier areas that chital were associated with water supplies (De & Spillett 1966). Chital in Texas are found in vegetative types closely resembling those described by Spillett, and in dry regions they are more common along streams.

The largest continuous population of a single species is the nilgai which occupies a 1000-square mile area including King Ranch, Inc. and adjoining ranches along the lower Texas coast. This single population of 2200-2400 animals is reproducing well and expanding its range (Sheffield *et al.* 1971). The vegetative description of the nilgai's Indian habitat by Spillett (1968) and Sankhala (1964) is also appropriate to its Texas habitat—a dry deciduous forest or dry deciduous thorn forest with nilgai being more common in the drier more open areas.

Blackbuck are found in small numbers in the coastal plains, perhaps similar to that described by Daniel (1967) for southern India. The largest numbers occur in rangelands of the Edwards Plateau, a habitat consisting of an interspersion of scrub oaks and grassland. Blackbuck are successful in the open scrub which they utilize readily as escape cover. They seem more tolerant of overstory canopy than the native pronghorn (*Antilocapra americana*).

Sambar deer are present in smaller numbers with very limited distribution and it is difficult to assess their establishment. One population of 50 animals occurs in the Gulf Prairies and Marshes vegetative area. On the ranch where they occur, along with 1200 chital, the sambar remain almost exclusively in thickets of the larger live oak. They are frequently seen feeding on submerged aquatic vegetation in 1-3 foot deep brackish lakes adjacent to the coast. A second small herd in the Edwards Plateau remains close to a small freshwater lake and have been observed feeding on aquatic vegetation. It appears that their distribution is restricted by habitat preference. However, in India they are widely distributed through seemingly similar habitats to those in Texas.

Red deer are more widely distributed than sambar deer, but because of their close similarity to native elk (*Cervus canadensis*) and their large size, they are not very popular. They adapt well to semicaptivity, but when confined together they breed with elk. The offspring of this mating is neither as valuable as the elk nor the red deer.

Barasingha exist on only a few ranches, and in such small numbers that little is known about their habitat in Texas. Other species of Indian mammals are confined to zoos.

Discussion

Climatic and vegetational similarities between habitats in India and Texas probably account for the success of most exotics. Also, since most populations in Texas were produced by zoo stock, they were already somewhat acclimatized. Supplemental feeding of newly acquired animals and protection from unwanted hunting further insured their survival. Throughout the region where exotics have been most successful there are few large predators. Coyote (*Canis latrans*) control is practiced intensively by ranchers who raise sheep and goats.

The potential natural spread of these exotics into other parts of Texas and into adjoining states is only speculative at the present. Low winter temperatures would seemingly limit the northern spread of many Indian antelope and deer. The blackbuck is sensitive to sub-freezing temperatures. Heavy mortality has occurred in some herds during late winter when food supplies were minimal and either snowstorms or cold rains produced additional stress. Young nilgai are born during all months, but the peak of births is August-September, a season unfavourable for survival of young throughout much of the northern United States. The peak of births among chital in Texas is February-March, though some young are born during all months. In that region of Texas containing most chital late winter weather is not severe enough to hinder survival, but would likely prove fatal to fawns born further north. The same is true for all other species that give birth year-round or during the winter season.

Exotic ungulates seem well established and are becoming an accepted part of ranching and sport hunting enterprises in Texas. Exotics offer the sportsman unusual and unique opportunities. He can easily pursue trophy animals that would otherwise require considerable investments of time and finances if hunted in their native lands. To the landowner exotics offer some advantages over native species. Native game species are regulated by state game laws with bag limits and seasons being restricted. However, exotics are not regulated by game laws and may be harvested at the landowner's discretion. A group of several species can provide year-round hunting since reproductive patterns of exotics are different from native animals.

The potential of exotic game for meat production has not been an important consideration in the past, but presently there is an increasing interest in the potential of exotic animals as meat producers. Some species are better adapted to arid and semi-arid regions than are domestic livestock and some range scientists now suggest that selecting an animal species compatible with the vegetation is a better approach than altering the habitat to fit the animal. Thus, exotics are likely to occupy some role in ranching enterprises in Texas for some time to come.

ACKNOWLEDGEMENTS

Unfortunately most introduced ungulates in Texas were released with little or no knowledge of their biology, habitat requirements and possible consequences to native biota. To increase our understanding of exotics and their role in ranching enterprises in Texas a series of investigations were begun in 1967 by the Department of Wildlife and Fisheries Sciences of Texas A & M University. These studies were financed by a grant from the Caesar Kleberg Foundation for Wildlife Conservation. We gratefully acknowledge their support of this research programme.

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Common edible Mushrooms of Jammu and Kashmir[1]

BY

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(*With five figures in two plates*)

The region, because of its varied climate and topography, offers a rich field for mushroom collection. Description of common edible species along with field notes for mushroom collectors are provided. Four edible mushrooms from Kashmir valley, *Coprinus atramentarius* (Bull.). Fr., *C. comatus* Fr., *C. micaceus* (Bull.). Fr. and *Pleurotus salignus* Fr. and one from Jammu Province *Pleurotus ostreatus* Fr. white form, are described. Two *Pleurotus* species are new records for India, while the other three have been recorded from Kashmir valley for the first time.

INTRODUCTION

The Kashmir valley has a variety of mushrooms, which are collected regularly by villagers for consumption. A few like Morels (*Morchella* spp.; *Verpa* spp.) and to a lesser extent *Pleurotus* ('Dhingri' local name) are collected in bulk, dried and exported to different parts of the country. The annual export of dried morels from the State is about 12,000 kg valued at a million rupees.

Mushroom hunting if indiscriminate can lead to fatal accidents due to eating of poisonous ones. This series of papers is published with a view to make available to mushroom lovers a field guide for collection and identification of edible mushrooms and also a description of the species recorded is given to assist students of mycology.

Genus *Coprinus* (Pers.) Fr.

This genus is characterised by black spore deposits and conversion of cap and gills into black inky fluid. They are commonly referred to as ink caps and are easy to recognize in the field. The plants vary in

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[1] Accepted October 24, 1970.

size and some grow several inches high and more than an inch in breadth. A number of species grow on dung or recently manured ground, while some live on humus and others grow on wood. Most of the larger ones are edible in immature stages. Their only drawback is that they must be picked before they mature and used almost at once. The three species described here are said to be the best edible species in the genus.

Coprinus atramentarius (Bull.) Fr. Syll. Fung. 5:1081, 1887.

Cap: (Pileus) 7 mm to 30 mm wide in button stage and 30-50 mm × 40-70 mm in adult stage, at first conical to egg shaped, later broadly conical covered with grayish bloom which is readily rubbed off. Colour varies from light brown to dark brown, surface mostly smooth, excepting small scales near the top or occasionally at the centre with fine lines or striations marking the entire surface. The marginal half of the cap is furrowed irregularly, forming an uneven edge.

Gills: 4-6 mm (button) and 10-15 mm (adult) wide, crowded, creamy white in young specimens, then pinkish grey and finally black, liquefying from the margin towards the centre.

Stem: 1.5 to 8 cm long, 10 mm to 15 mm thick, hollow, smooth, white and shiny above the faint annulus and provide with small upward pointing scale below. Annulus forms an irregularly zigzag elevated lines of thread which extend around the stem near the base.

Spores: 8-14 × 5-7 μ. elliptical, black.

Collected on ground near the base of trees or on pieces of decomposing wood at Chundinah willow plantation (5200′ a.s.l.) 22.iii.1970, T.N. Kaul and J.L. Kachroo, RRLS No. 1, Fig. I.

Reported earlier from Allahabad. New record from Kashmir.

Field notes: *Coprinus atramentarius* is the most common among the edible species of *Coprinus* and forms an article of commerce in the valley. The species fruits during cold wet weather in spring mainly but some crop also appears during summer and fall. Extensive collections are made by villagers from Government willow plantation at Chundinah (Kashmir). Mushrooms grow in dense clumps near the base of standing trees, cut stumps or on decaying wood. The soil is sandy, full of peat and submerged during summer.

An irregular zone of squamules (scales) extending from the base of the stalk for a short distance distinguishes it from other edible species of the genus.

There is no local record of poisoning from the species. Smith (1958), however, refers to the controversy regarding the adverse effect of this species specially in combination with alcoholic beverages.

Coprinus comatus Fr., Syll. Fung., 5:1079, 1887. Berk. in J. Bot. 3, 8, 1856 Banerjee in Bull. Bot. Soc. Bengal 1; p. 42.

Cap: (Pileus) 4-10 cm long, 2-3 cm wide, at first egg shaped, becoming campanulate or barrel shaped as it matures and margin often splitting into lobes, turning into umbrella shape at dissolution. Surface shaggy, covered with prominent brown scales, close together on the buttons and widely separated in the adult stage, sometimes arranged concentrically, white between the scale.

Gills: 6-10 mm wide, free, crowded, creamy white first, pink later, finally black and becoming liquid.

Stem: 4-14 cm long, 10-15 mm thick at the top and 20-25 mm at the base, tapering slightly upwards, white and mostly smooth; hollow even at the young stage with delicate cord suspended in the cavity. Annulus in the form of free movable ring on the stem, generally resting at the base or vanishing entirely.

Spores: 12-18 × 5-7 μ elliptic, black.

Collected on the side of a rivulet in Sanat Nagar, Srinagar (5200′ a.s.l.) 17-iv-1969 T. N. Kaul & J. L. Kachroo RRLS No. 6, Fig. 2.

Reported from Bombay, Darjeeling and Calcutta on lawns and refuse dumps. New record for Kashmir.

Field notes: *Coprinus comatus* commonly referred to as shaggy mane is easy to identify in the field. Besides the dissolution of the ripening cap into a black liquid it is characterised by scaly surface and narrow loose ring round the stem in earlier stages. European authors have classed it as one of the best among edible fungi.

It has been noticed in the valley growing mainly on the sides of rivulets in shady places from late April to October, mostly solitary, rarely in clumps. Villagers collect the closed button stage for consumption.

Coprinus micaceus (Bull.) Fr. Syll. Fung; 5:1090, 1887; Banerjee in Bull. Bot. Soc. Bengal I: 42.

Cap (Pileus) 20-40 mm wide, at first ovate then conical to campanulate, tan or yellowish brown in colour with prominent striations from the margin up almost to the centre. Surface covered with shining particles.

Gills 3-4 mm wide, crowded, first white then tan, later black, and liquefying.

Stem 4-8 cm long, 3-6 mm thick, slender, fragile, hollow and white. Annulus rarely visible.

Spores 10 × 5 μ, blackish, sometime brown elliptical.

Collected around stumps of *Robinia pseudoacacia*, in shady moist places in Sanat Nagar, Srinagar (5200′ a.s.l.) 9-iv-1970. T. N. Kaul & J. L. Kachroo, RRLS No. 3, Fig. 3.

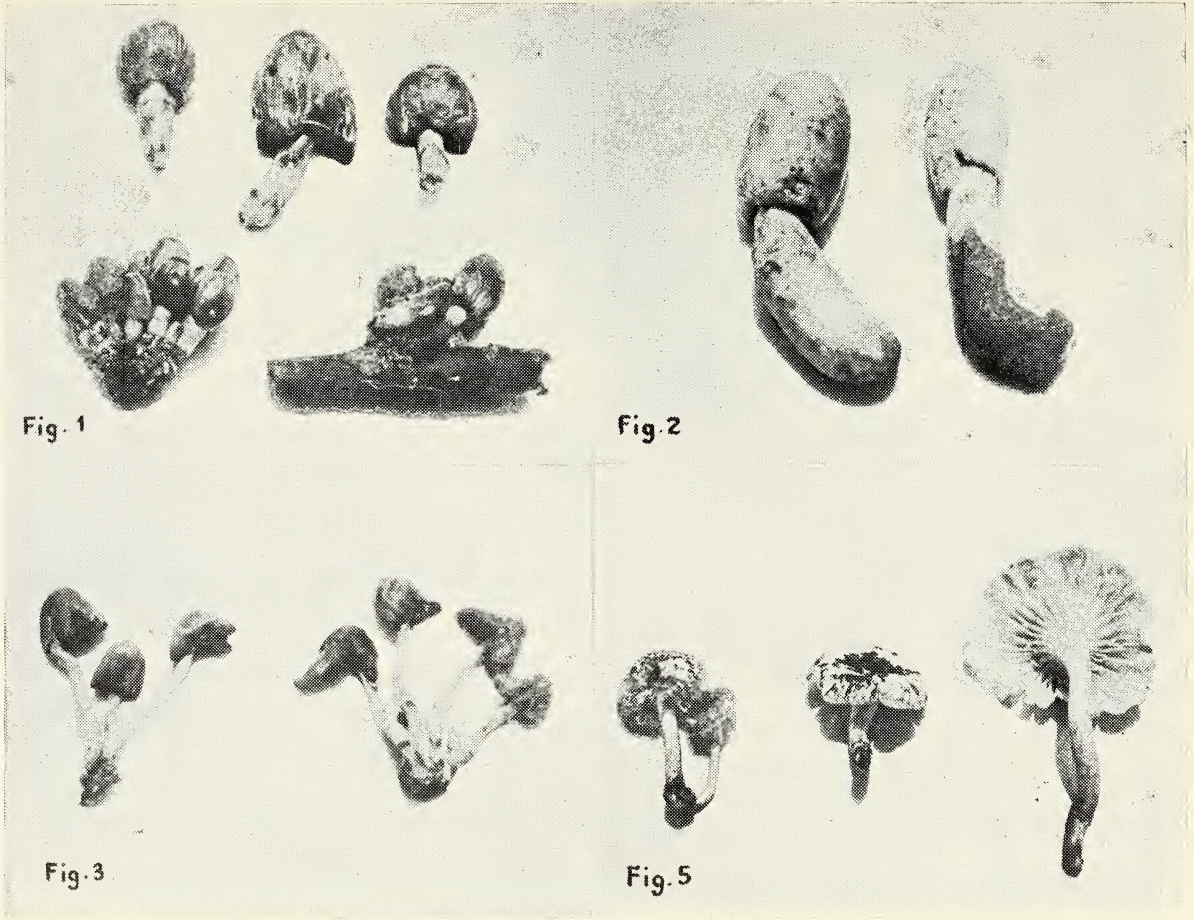
Fig. 1
Fig. 2
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Fig. 1. *Coprinus atramentarius* Fig. 2. *Coprinus comatus*
Fig. 3. *Coprinus micaceus* Fig. 5. *Pleurotus salignus*

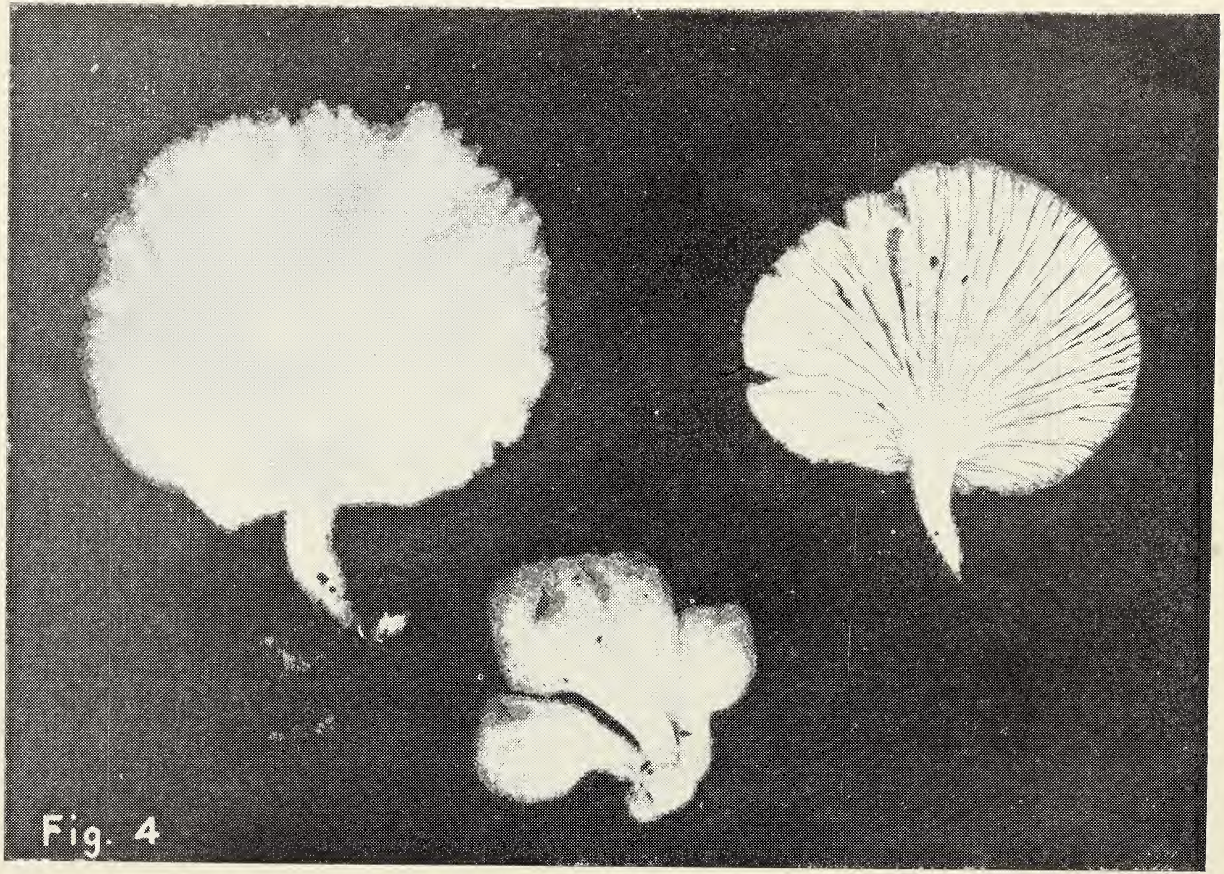

Fig. 4. *Pleurotus ostreatus* white form

Reported from Calcutta (West Bengal). New record for Kashmir valley.

Field notes: This mushroom appears in clumps near the base of standing trees of *Populus* spp., *Salix* spp., *Robinia* spp. or around their cut stumps in the valley. Grows in tufts of ten to thirty or more individuals. It appears in spring, summer and autumn in cool wet weather. It is commonly referred to in literature as glistening *Coprinus* because of the delicate scales covering the surface of the pileus which glistens in light like particles of mica. Prominent striations on the Cap and glistening scales distinguish it from other species of *Coprinus*. Since this mushroom occurs in clusters it offers a good meal to the villagers who collect it.

Genus *Pleurotus* Fr.

The genus is characterized by spore deposits of white colour when the cap is left for few hours on a clean surface; an eccentric or lateral stem; fleshy or tough texture of the cap. There is no annulus. Almost all species of *Pleurotus* grow on trees or on dead wood.

Pleurotus ostreatus Fr. white form, Syll. Fung., 5:355, 1887.

Cap 1.5-12 cm wide, 2-10 cm long, soft, fleshy, convex or slightly depressed near the point of attachment. White, light grey or dark grey, often becoming yellow on drying, spatulate to kidney shaped, margin inrolled, imbricate in groups of 4-10 or more. Sessile or with a short stem.

Gills 5-10 mm wide, white, broad, decurrent, anastomosing at the base.

Stem when present short 1-3.5 cm long, 0.2-1 cm thick, lateral or eccentric.

Spores 8-11 × 3.3-4.3 μ, subcylindric, not amyloid.

Collected on decaying logs of *Euphorbia royleana* Boiss. from Katra Forests, Jammu (1000′ a.s.l.) 13-ix-1966, T. N. Kaul & K. K. Janardhanan, Fig. 4.

The specimens were referred to Mr. E. J. H. Corner of Botany School, Cambridge who considers them close to *Pleurotus eugrammus* (Mont.) Dennis but in the absence of thorough study identified it as "*P. ostreatus* white form". *P. ostreatus* has not earlier been recorded from India. It is thus a new record. Corner (Personal communication) records the prevalance of the same white form in North Borneo. The detailed microscopic characters communicated by Prof. Corner are also recorded here.

Basidia 30-38 × 6 μ, 4 sterigmata. Cheilocystidia as sterile basidia or more inflated 5-8 μ wide, some with a short appendage, ill defined and not forming a sterile edge. Hyphae monomitic, clamped, 4-15

(–25) μ wide, the cells 40-230 μ long, the walls 0.5 μ thick but strongly thickened –2 μ at the base of the stem.

Field notes: *Pleurotus ostreatus* is known as the oyster agric as the form of the plant suggests the outline of an oyster shell. It is an excellent edible mushroom with considerable host range. This mushroom locally known as "Dhingri" forms an article of commerce in the plains of Jammu and is even exported outside the State, as it can be preserved well after drying.

The mushroom is abundant during the rainy season (August-September) on decaying stumps of *Euphorbia royleana* ("Thor" local name) which occurs commonly from Jammu to Udhampur. Extensive collections for the market are made in Thor plantations in Katra area of Jammu Province.

Collection and identification in the field is easy because of the characteristic shape and specific host in the region.

Pleurotus salignus Pers (Fr.) Syll. Fung 5:359, 1887.

Cap (Pileus) 1-8 cm wide, convex to expanded, depressed in the centre, margin involute, surface white covered with brownish black scales which give mottled appearance especially in young stages wearing off in mature specimens.

Gills 4-5 mm wide, white becoming yellow with age.

Stem nearly central, 2-10 cm long and 1-2 cm in thickness.

Spores 6-10 × 3-5 μ, elliptical, white.

Collected on willow (*Salix alba*) stumps at Chundinah willow plantation, Kashmir (5200′ a.s.l.) 22-iii-1970, T. N. Kaul & J. L. Kachroo, RRLS No. 2, Fig. 5.

New record for India. *P. dryinus* has been recorded earlier from Awantipora, Kashmir on undetermined host. However, most of the authors have designated the *Pleurotus* on willow as *P. salignus.*

Field notes: This species has been found associated throughout the valley with willow trees, mostly growing round cut stumps in moist shady places. It appears in abundance during spring but it also available in summer, and autumn when the weather is cool and wet. Characteristic mottling of the cap surface and association with willow trees distinguishes the mushroom in the field.

ACKNOWLEDGEMENTS

We are thankful to Dr. K. Ganapathi, Director for encouragement in the work and to Prof. E. J. H. Corner, Botany School, Cambridge (U.K.) for determination of *Pleurotus ostreatus.*

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Preliminary observations, on the breeding of pearl oysters, *Pinctada fucata* (Gould) of the Gulf of Kutch[1]

BY

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(*With two text-figures*)

The pearl oysters of the Gulf of Kutch breed twice in a year. The primary breeding season is during winter, i.e. December to January, which is followed by a secondary less significant breeding period in early summer, i.e. April to May.

The stimulus for breeding does not appear to be in relation to the changes in salinity and temperature, as there is great variation in the salinity and temperature values during these two breeding seasons.

INTRODUCTION

While the biology of the pearl oysters of the Gulf of Mannar has been studied in detail by Herdman (1903-06), Hornell (1916 & 1922) and Malpas (1929 & 1933), those in the Gulf of Kutch have not received much attention in this regard. Hornell (1909) and Easwaran, Narayanan & Michael (1969) concentrated mainly on the fishery aspects and Gokhale, Easwaran & Narasimhan (1954) and Narayanan & Michael (1968) dealt mainly with the dimensional relationships of these bivalves. So much so, the biology in general, and the breeding habits in particular, of the oysters of this locality have not been studied by previous authors. This paper presents the preliminary observations made on the breeding habits, with particular reference to the spawning season of the pearl oysters of the Gulf of Kutch. The present studies

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form a part of the scheme for research and investigation on the pearl oysters of the Gulf of Kutch, implemented by the Directorate of Fisheries, Government of Gujarat, through its Research Station at Jamnagar.

I have made a detailed study on the taxonomy of the Gulf of Kutch pearl oysters and find them to be the typical Indian species referable to *Pinctada fucata* (Gould, 1850: *Proc. Boston. Soc. Nat. Hist.* **3**: 309-312) [Syn. *Pinctada vulgaris* (Schumacher)], which nomenclature is used in this paper. No other species of the Genus *Pinctada* (Bolten) has been observed in the collections from this locality.

Materials and Methods

About five hundred oysters collected from the pearl oyster *Khaddas* of the Gulf of Kutch and reared in a Sea Water Tank at Sikka (Jamnagar District, Gujarat State) by the Fisheries Research Station, Government of Gujarat, Jamnagar, constitute the material for the present studies. Regular samples of living oysters were measured, weighed and their gonads examined afresh every fortnight. Side by side, the salinity and temperature of the sea water of the tank were also recorded regularly.

As adopted by Gokhale *et al.* (1954) and Narayanan *et al.* (1968), the thickness denotes the maximum distance between the external surfaces of two valves and hinge-width the maximum distance between the edges of the two valves at the hinge. The whole-weight indicates the weight of the animal inclusive of the valves and flesh-weight, the weight of the body exclusive of the valves. (Special care has been taken to see that the water particles are blotted out from the flesh to the maximum possible extent and to obtain the accurate weight of the flesh). The linear measurements, referred to above, were made with a pair of Dial Calipers and represented in millimeters. The flesh and whole weights were measured in a Chemical Balance and represented in grammes.

For the sake of convenience, the gonads were classified into five stages, basing on their stage of development, as follows:

Stage 0 : Resting/Immature Gonad
Stage I : Developing Gonad
Stage II : Ripe Gonad
Stage III : Running or Oozing Gonad
Stage IV : Spent Gonad

While classifying the gonads, as above, there were a few oysters whose gonads could not be catagorised, as the gonad-development was too obscure. Such gonads are indicated as 'Un-identified Gonads'.

Observations on the gonads and their contents were made from fresh specimens only, so as to avoid any shrinkage of the tissue. Body dimensions and stage of development of the gonads were recorded against each specimen at regular intervals.

OBSERVATIONS

It has been observed, as a general rule, that a male gonad is creamy white and the female gonad yellowish to dark-yellow in external appearence, when they are fully ripe. However, at times when the gonad is infested by a trematode parasite[1]—which is a very common phenomenon in the Gulf of Kutch oysters—the external coloration of the gonads of either sex is pinkish-red.

The age at first maturity of these oysters has not been correctly estimated so far. Tranter (1958a & 1958d) has observed that the Australian pearl oysters, *Pinctada albina* (Lamarck) and *Pinctada margaritifera* (Linnaeus) attain sexual maturity around the first year of their life. Gokhale *et al.* (1954) contended that the Gulf of Kutch oysters attain sexual maturity towards the third or fourth year. I do not agree with their view, as on many occasions I have examined the gonads of oysters of below one year, one year and two years and have found them to be fully ripe. My observations reveal that, in general, the Gulf of Kutch pearl oysters attain sexual maturity at a hinge-width of 2 to 2.5 mm and a thickness of 18 to 22 mm. Narayanan *et al.* (1968) have observed that the mean thickness and hinge-width of these oysters at the end of the first year are 21.9 mm and 2.5 mm respectively. This, therefore, should mean that the age at first maturity of the pearl oysters of this locality cannot be more than one year. Unfortunately, no definite conclusion can be arrived at in this regard and the exact age at which these oysters attain sexual maturity cannot be pin-pointed, as I have not examined sufficiently large number of oysters of one year and below.

The percentage of sex of the pearl oysters of the Gulf of Mannar has been estimated by Hornell (1916) as 55 males to 45 females. Tranter (1958d) observed the proportion of sex of *Pinctada margaritifera* (Linnaeus) of the Australian waters as five males to every female. In the Gulf of Kutch, however, the percentage of male and female has been worked out as 35.5 and 64.5 respectively.

Tranter (1958c) observed that the ratio of sex decreases until in old oysters the proportion is equal. According to him, such a pronounced variation is the result of a sex-change within the population.

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[1] The taxonomy of these parasites has not been worked out as yet.

Ojima & Maeki (1955) noted bi-sexual nature in the gonads of *Pinctada martensii*, but Herdman & Hornell (1903, 1904 & 1906) though recognizing the possibility of a sex-change in oysters, stated that their species (*Pinctada fucata*) was permanently dioecious. Wada (1938 & 1953) showed that *Pinctada martensii* and *Pinctada maxima* experienced change of sex.

The possibility of such a change of sex in the Gulf of Kutch oysters cannot altogether be ruled out as on many occasions my samples consisted only of one sex. But the data in this connection is not sufficient to substantiate this view. Also, it has not been possible for me to observe the same stock of oysters over a long period.

Breeding Season

The stage of development of the gonads examined afresh was determined and the percentage of each stage of development was worked out month-wise, as tabulated in Table 1.

As can be seen from the table, a great majority of the oysters were found to be in the resting stage during the months of June, July and August. In October, however, majority of the gonads were ripe and in November and December, oozing (running) ones formed the major percentage. In January and February, the spent gonads were more than those of the other stages. In March, about a third of the oysters were found to ripen again. In April, these were found to be in the running (oozing) stage and in May most of them were either spent or resting. These observations indicate that the actual or the primary breeding season of the pearl oysters in the Gulf of Kutch is November, December and January. This primary breeding season is followed, in some cases, by a secondary one in April-May.

The observations made on the whole weight- flesh weight relationship and other studies made on the seasonal variations in oysters also support this view.

The mean percentage of the flesh-weight in the whole-weight of the individual oysters were estimated monthwise and is shown in Fig. 1. As can be seen from the figure, the percentage of flesh-weight in the whole-weight increases from November onwards and this increase lasts up to February, after which the percentage falls. Again, from March onwards up to May there is an increase in the percentage. The percentage decreases in June, July, August and September. The whole-weight of the oysters includes the shells also, but the flesh-weight, on the other hand, indicates only the weight of the body within the shells. Since during sexual development, the gonads extend to almost all parts of the viscera, there are all possibilities of increase in

TABLE 1

Stage of Gonad Development				Monthwise percentage of different gonad stage								
	JUNE	JULY	, AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL	MAY
Stage '0'	93.80	90.30	87.00	67.40	20.00	05.00	—	—	35.50	21.30	40.00	47.00
Stage 'I'	—	02.70	08.00	25.60	23.00	17.00	02.00	—	04.5	33.7	—	—
Stage 'II'	—	—	—	06.00	55.00	24.00	20.0	--	—	22.0	26.0	—
Stage 'III'	—	—	—	—	—	53.00	70.0	23.6	—	02.0	30.5	14.0
Stage "IV"	—	—	—	—	—	—	06.0	75.4	60.0	20.0	3.5	39.0
Unidentified	6.20	7.00	05.0	01.00	02.00	01.00	02.00	01.00	—	01.00	—	—

the weight of the body. Hence, the increase in the percentage of flesh-weight in the whole-weight during the months of November-January and March-May invariably indicates the excessive gonad development and hence breeding season.

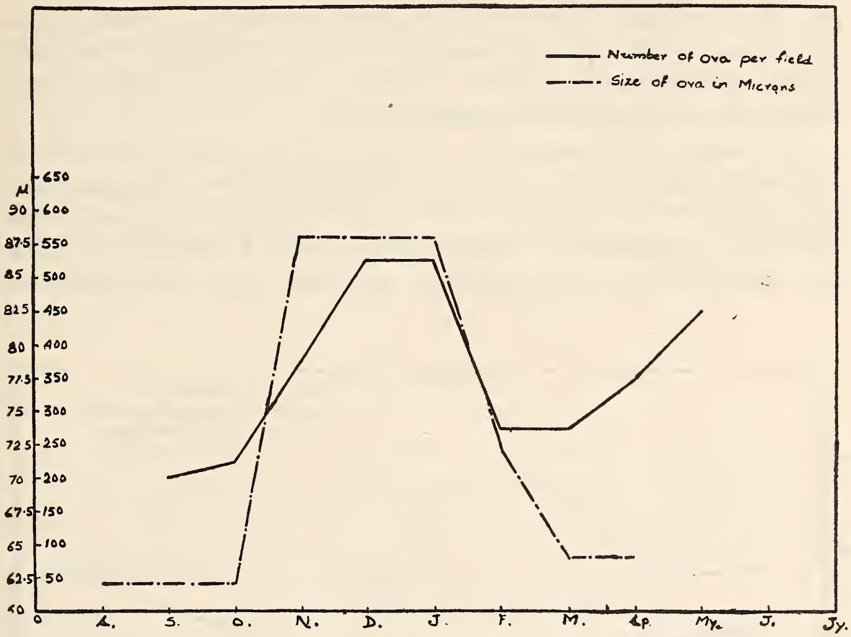

Fig. 1

Similarly, changes in the gonadial elements were also observed during the breeding season. The average ova count per field and the mean size of the ova were also found to increase corresponding to the breeding peaks. These changes have been plotted in Fig. 1.

As observed by Easwaran *et al.* (1969), there are no heavy spat-falls observed in the Gulf of Kutch, unlike in the Gulf of Mannar and Palk Bay. However, I have collected a few three to four month-old spats from the Pearl Oyster Reefs of Movada, during March-April, 1966. These spats, though scanty, do indicate that the oysters of the Movada Reef had bred somewhere between November, 1965, and January 1966.

TEMPERATURE AND SALINITY

Herdman & Hornell (1906), Hornell (1916) and Malpas (1929) have estimated that the Ceylonese and South Indian pearl oysters breed twice in a year, namely during the south-west monsoon and north-east monsoon seasons. The present observations show that the pearl oysters of the Gulf of Kutch also breed twice in a year; but the breeding maxima do not tally with those in the Gulf of Mannar and Palk Bay. This is probably because the hydrological conditions in the Gulf of Kutch are entirely different from those in the Gulf of Mannar and Palk Bay. Malpas (1929) believes that the changes in salinity and temperature induce the pearl oysters to spawn. According to him, high salinity in July-August and low salinity in December-January in the southern waters both act as breeding stimuli.

The salinity and temperature of the Gulf of Kutch have been recorded regularly by the Fisheries Research Station, Jamnagar, and are shown in Fig. 2. As can be seen from the figure, there is not much appreciable variation in the salinity of the Gulf of Kutch waters. This has been observed by Gokhale *et al.* (1954) also. The maximum

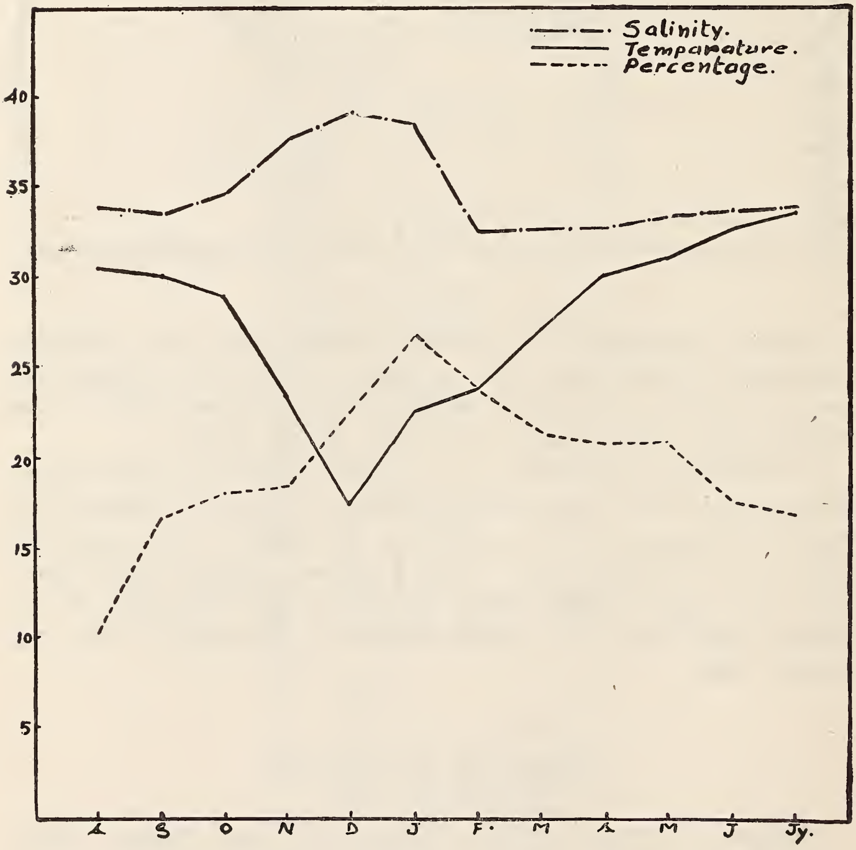

Fig. 2

salinity observed is 39‰ in December and minimum 32.18‰ in February-March. During the primary breeding season of the pearl oysters of this locality, the salinity is the maximum (37 to 39‰) and during the secondary breeding season, in April-May, the salinity is minimum (32.18 to 31.8‰). Malpas' (1929) contention that the oysters get spawning stimulii from both high and low salinity may appear to be quite true in regard to the pearl oysters of the Gulf of Kutch. But, as Dewanesan & Chidambaram (1956) put it, it will not be justifiable, though it cannot be proved with the information on hand, to believe that an animal can respond to different stimulii in the same manner.

Similarly, the contention that temperature variation too stimulates the pearl oysters to breed cannot be agreed to, as the mean temperature during the primary breeding season in December-January is 17.5 to 23.5°C and during the secondary breeding season, in April-May, the temperature ranges between 30 to 31°C (Fig. 2).

ACKNOWLEDGEMENTS

I am grateful to the Directorate of Fisheries, Government of Gujarat, Ahmedabad, for permission to publish this paper and to Messrs. C. R. Easwaran and M. M. Chhaya for their encouragement.

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Taxonomy and distribution of *Sardinella leiogaster* Valenciennes, 1847 [Pisces: Clupeidae] from the Indian Seas[1]

BY

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(*With a text-figure*)

INTRODUCTION

The Indo-Pacific representatives of the genus *Sardinella* Valenciennes fall into two subgenera, *Sardinella* Valenciennes and *Amblygaster* Bleeker distinguished, one from the other, by the degree of compression in the ventral keel and scutes, and by marked differences in the arrangement of the scales along the median line anterior to the dorsal fin. The specific identity of *S.* (*Amblygaster*) *leiogaster* Valenciennes has been in great confusion, the species having either placed in the synonymy of *Sardinella sirm* (Walbaum) (by Regan 1917; Fowler 1941; Misra 1947) or confused with *Sardinella clupeoides* (Bleeker) (Bertin 1944). Recently Chan (1965), Whitehead, Boeseman & Wheeler (1966), and Whitehead (1967*a*) revised systematics and recognised *Sardinella sirm* (Walbaum), *S. clupeoides* (Bleeker) and *S. leiogaster* Valenciennes as three distinct species under the subgenus *Amblygaster*.

During a recent survey of the Andaman and Nicobar group of Islands, as a part of a comprehensive programme of survey of the ichthyo-fauna of these islands by the senior author, a specimen 242 mm in total length, of *Sardinella leiogaster* Valenciennes, hitherto not recorded from Indian waters, was collected from the Car Nicobar

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[1] Accepted March 4, 1972.

Island on 14th March, 1969. This species has so far been known to occur from the East African coast, the Red Sea, Indian Ocean, Singapore, the East Indies and the Philippines (*vide* Whitehead 1967*b*). It is here recorded for the first time from the Indian waters. The specific identity of earlier records (Day 1878; Hornell 1917; Deraniyagala 1929, 1952; Munro 1955; Kuthalingam 1961) of the three species of the subgenus *Amblygaster* from the Indian Seas are discussed.

SYSTEMATIC ACCOUNT

Sardinella (Amblygaster) leiogaster Valenciennes

Clupea caeruleo-vittata Richardson,[2] 1846, *Ichth, China Japan,* p. 305; Whitehead, 1966, *Bull. Br. Mus. nat. Hist.* (*Zool.*) *14*(2):28.

Sardinella leiogaster Valenciennnes, 1847, *Hist. nat. Poiss. 20*:270 (Indian Ocean); Kner, 1865, *Reise Novara, Fische*: 327; Chan, 1965, *Jap. J. Ichthyol. 12*(3-6): 117, fig. 15; Whitehead, Boeseman & Wheeler, 1966, *Zool. Verhandl. Leiden 84*:47 (Key); Whitehead, 1967, *Bull. Br. Mus. nat. Hist.* (*Zool.*),:Suppl. 2: 68 (Redescription of type); Whitehead, 1967, *J. mar. biol. Ass. India 9*(2):235, fig. 13.

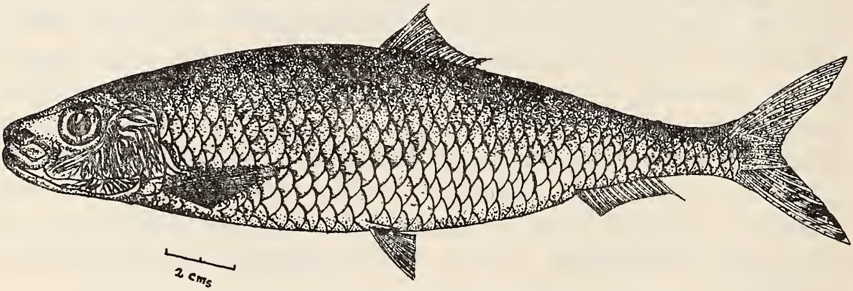
Clupea leiogaster Klunzinger, 1871, *Verh. zool.-bot. Ges. Wien. 21*: 598.

Clupea (*Amblygaster*) *leiogaster* Bleeker, 1872, *Atlas Ichthyol. Ind. Neerland.* 6: 102; Weber and de Beaufort (*partim*), 1913, *Fishes Indo-Australian Archipelago* 2:61; Deraniyagala, (*partim*), 1929, *Spoilia Zeylanica 15*:37.

Sardinella clupeoides Fowler (*nec.* Bleeker), 1941, *Bull. U.S. nat. Mus.* (100) *13*: 619.

Sardinella (*Amblygaster*) *sirm* Deraniyagala (*nec.* Walbaum) (*partim*), 1952, *Coloured Atlas of some Vertebrates from Ceylon 1*: 14.

Amblygaster clupeoides Munro, 1955, Marine and Fresh water fishes from Ceylon: 26.



Sardinella (*Amblygaster*) *leiogaster* Val.

MATERIAL:

1 ex., 210 mm in standard length; Teetop (Car Nicobar Island); 14th

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[2] putative *nomen oblitum* vide Whitehead, *Bull. zool. Nomencl. 23* (pt. 1): 62-64, 1966.

March, 1969; Coll. P. K. Talwar; Zoological Survey of India, Reg. No. F. 6168/2.

DESCRIPTION:

Br. St. VI, D IV 14, P i 16, V i 7, A iii 13.
Scales in the lateral series 42, 11 transverse.
Predorsal scales 14.
Abdominal scutes 16 + 12.
Gillrakers on first arch 17 + 1 + 35.

In percentages of standard length: body depth 22.8; head length 23.3; snout length 7.6, eye-diameter 6.0, length of upper jaw 8.0, length of lower jaw 8.8, pectoral length 15.0, pelvic length 8.5, length of anal fin base 11.9, pre-dorsal distance 51.4, pre-pelvic distance 51.4, pre-anal distance 76.7.

Body oblong, elongated, sides slightly compressed; weakly keeled medio-ventrally, with blunt scutes which are not prominent. Maxilla not reaching to the vertical from anterior edge of eye; two supra-maxillae, the second (posterior) almond-shaped but profiles of both portions meeting the anterior shaft at about the same point as illustrated by Whitehead (1967 *a*, fig. 1a). Pseudobranch present, exposed, about as long as eye-diameter; filaments long, ventral base crescentric and without groove below it. Gillrakers rather short, slender, shorter than the corresponding gill filaments. Cleithral lobe prominent. Fronto-parietal region with 14 longitudinal striae. Teeth absent except for a patch of minute, feeble teeth on tongue and palatines. Opercular bones, postorbitals and suborbitals covered by translucent adipose tissue, under which minute hollow venules spread downwards in a radiating pattern.

Dorsal fin origin equidistant between snout tip and caudal base. Pelvic fin base below first branched dorsal ray.

Scales cycloid, thin; deciduous. Predorsal median ridge before dorsal fin covered by a single longitudinal series of scales. Scaly sheath cover the bases of dorsal and anal fins. Elongated axillary scales in angle of pectoral and pelvic fins. Alar scales present.

Colour in alcohol—Upper one-third slate-grey, flanks pale brownish; tips of jaws dusky. Caudal slightly dusky.

DISCUSSION

Our specimen agrees very well with the description; keys and figures given by Chan (op. cit.), Whitehead, Boeseman & Wheeler (1966), and Whitehead (op. cit.).

Day's (1878, 1889) record of *Clupea leiogaster* (Val.) from Sri

Lanka with the maxilla reaching to below front edge of eye and with 13-20 blue spots along the flanks, is evidently based on an erroneous identity of *Sardinella sirm* (Walb.); there are no spots along the flanks and the maxilla does not reach the vertical through the anterior edge of eye in *S. clupeoides* and *S. leiogaster*, (*vide* Chan, op. cit.; Whitehead *et al.*, op. cit.). Hornell (op. cit.) listed *Clupea leiogaster* (Val.) as one of the principal food fishes caught off Tuticorin (south-east coast of India) and based his identity on Day's (1889) description of the species which is here considered conspecific with *Sardinella sirm*.

Munro's (1955:26) record of *Amblygaster clupeoides* (Blkr.) from Sri Lanka with 17-22+32-33 gillrakers, is undoubtedly *Sardinella leiogaster* Valenciennes as *S. clupeoides* (Blkr.) has a lower count (26-30 vs. 31-36) (*vide* Whitehead *et al.*, op. cit.). Deraniyagala (1929, 1952), however, correctly reported *S. clupeoides* from Sri Lanka with 27-29 gillrakers but his *S. sirm* with 30-40 gillrakers is clearly a mixture of both *S. sirm* and *S. leiogaster*. Kuthalingam's (op. cit.) record of *S. clupeoides* from Madras is erroneous as in no species of the subgenus *Amblygaster* does the maxilla reach below the middle of the eye.

Hornell (op. cit.—as *Clupea leiogaster*) and later Menon (1961) recorded *Sardinella sirm* (Walb.), and Bonnett (1965) reported *Sardinella clupeoides* (Blkr.) for the first time from Indian waters. All the three species of the subgenus *Amblygaster*, therefore, occur in the Indian and Sri Lanka waters. A key to the field identification of the three species of the subgenus *Amblygaster* is given below:

I. A series of 10-12 dark blue spots along flank; maxilla reaching vertical from anterior eye border .. .. *sirm* (Walb.)

II. No series of spots on flanks; maxilla not reaching vertical from anterior eye border.

   a. Body moderately heavy; dorsal fin origin slightly nearer to tip of snout than to caudal base; gillrakers 26-30. .*clupeoides* (Blkr.)

   b. Body slender, elongated; dorsal fin origin approximately equidistant between tip of snout and caudal base; gillrakers 31-36 *leiogaster* Val.

SUMMARY

Sardinella (*Amblygaster*) *leiogaster* Valenciennes, belonging to the family Clupeidae is recorded for the first time from Indian waters, the earlier record by Hornell (1917) being due to mistaken identity. The specific status of earlier records of the three species of the subgenus *Amblygaster*, which was in great confusion until Chan (1965), Whitehead, *et al.* (1966) and Whitehead (1966) revised the systematics, from the Indian Seas has been cleared and the distributional limits discussed.

ACKNOWLEDGEMENT

We are grateful to Dr. P. J. P. Whitehead, British Museum (Natural History), London for kindly confirming the identification of our specimen.

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A new Copepod from Ratnagiri

BY

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(*With twelve figures in three plates*)

In the month of January 1962, a number of copepods were collected from the mantle cavity of *Solen kempi* Preston, from the sandy beaches of Purangad, ten miles south of Ratnagiri. On a closer examination of the material, it was found that the copepods were not described previously. This was also confirmed by Dr. J. H. Stock, who kindly examined the specimens and offered great help in the preparation of this account.

Leptinogaster stocki sp. nov.

Material and types:

Several ovigerous females and adult males were collected from the mantle of *Solen kempi* from Purangad near Ratnagiri. (Type to be incorporated later).

The specific name *stocki* is proposed in honour of Dr. J. H. Stock of Zoologisch Museum, Amsterdam (Netherlands).

Description of the adult female:

Body cyclopoid ,somewhat flattened (Fig. 1). Length of the body excluding the caudal seta 3.0 mm, width 1.0 mm. The prosome equals the length of urosome and is four segmented. The first prosomal segment is larger and nearly equals the length of the remaining three segments. It is slightly wider than long and the length-breadth proportion is 45:55. Rostrum is distinct and triangular in shape. The cephalosome is ovoid anteriorly whereas the posterior end is almost straight. The remaining four pedigerous segments become, successively narrower and are separated by deep incisions. There is a wide gap between the segments bearing fourth and fifth pairs of legs. The urosome is five segmented and bears the reduced fifth pair of legs on its first segment, which is the widest. The genital segment is longer than wide. The remaining three segments are shorter than the genital segment. All the urosome segments become successively narrower. The last three seg-

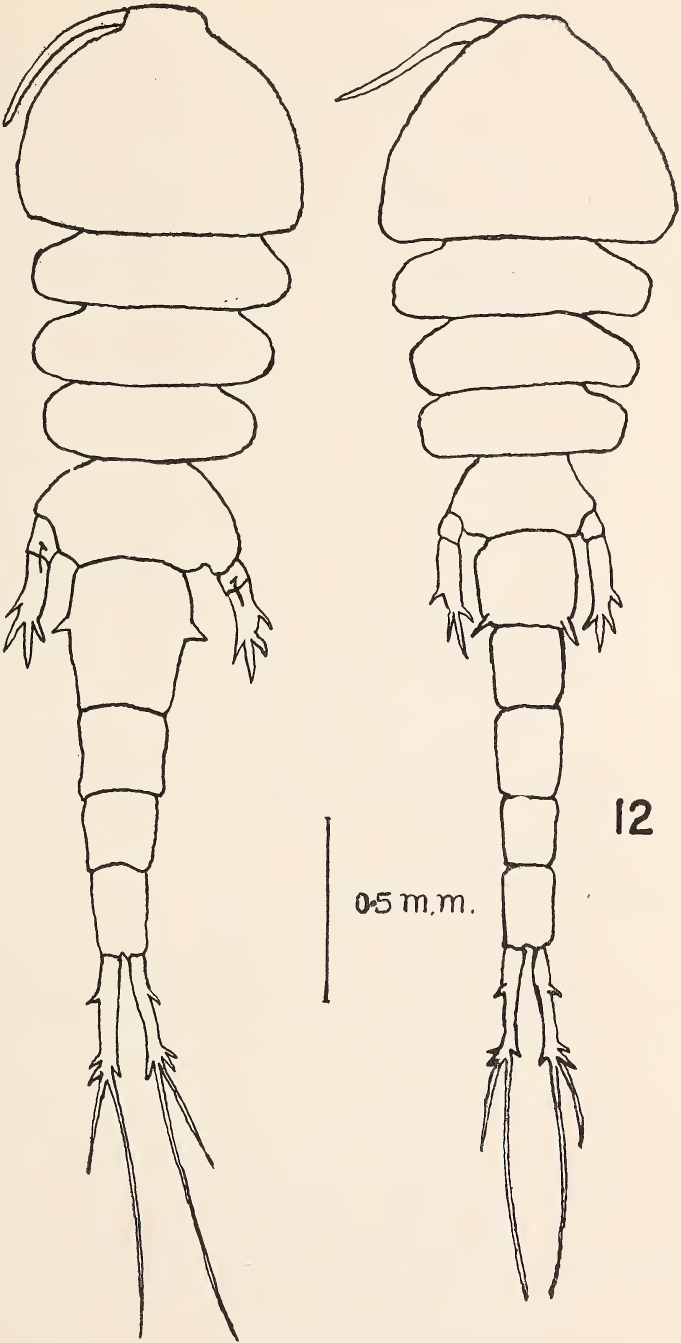
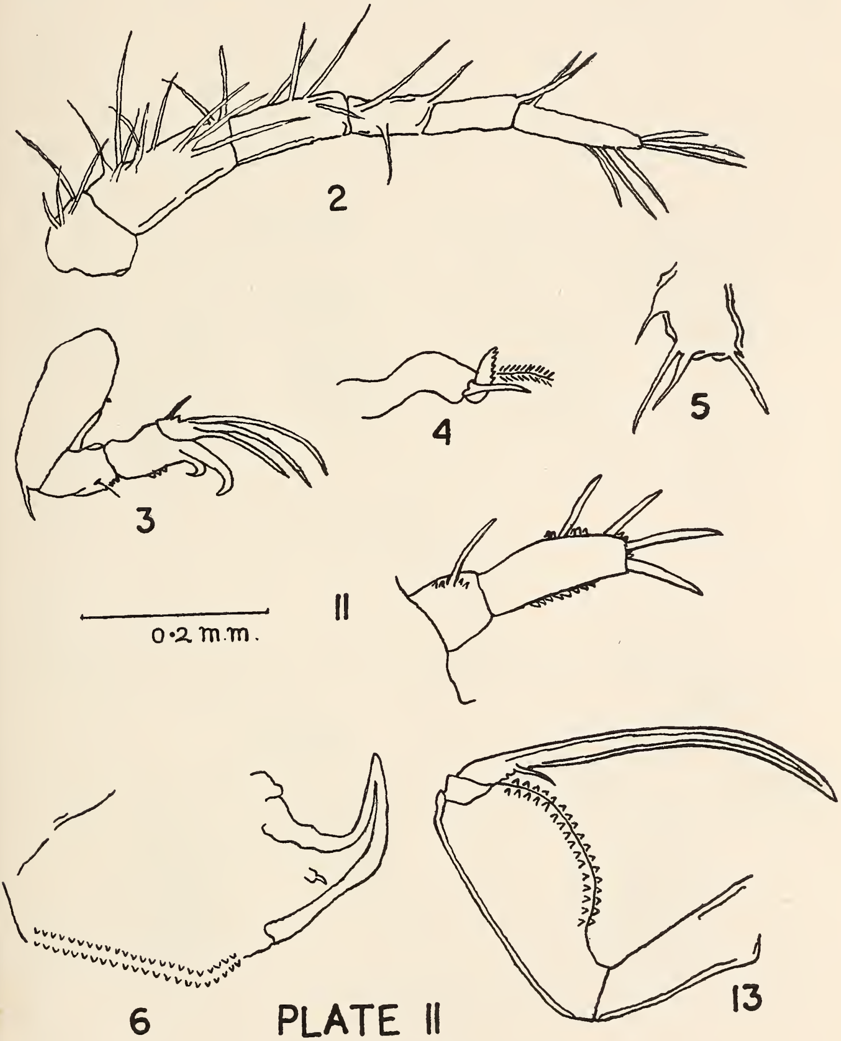


PLATE I

Leptinogaster stocki sp. nov.

Fig. 1. Adult female (x 75), dorsal view. Fig. 12. Adult male (x 75), dorsal view.



Leptinogaster stocki sp. nov.

Adult female. Fig. 2. First antenna (x 400); Fig. 3. Second antenna (x 400); Fig. 4. Mandible (x 400); Fig. 5. Maxillule (x 400); Fig. 6. Moxilla; Fig. 11. Fifth leg. *Adult male.* Fig. 13. Maxilliped (x 400).

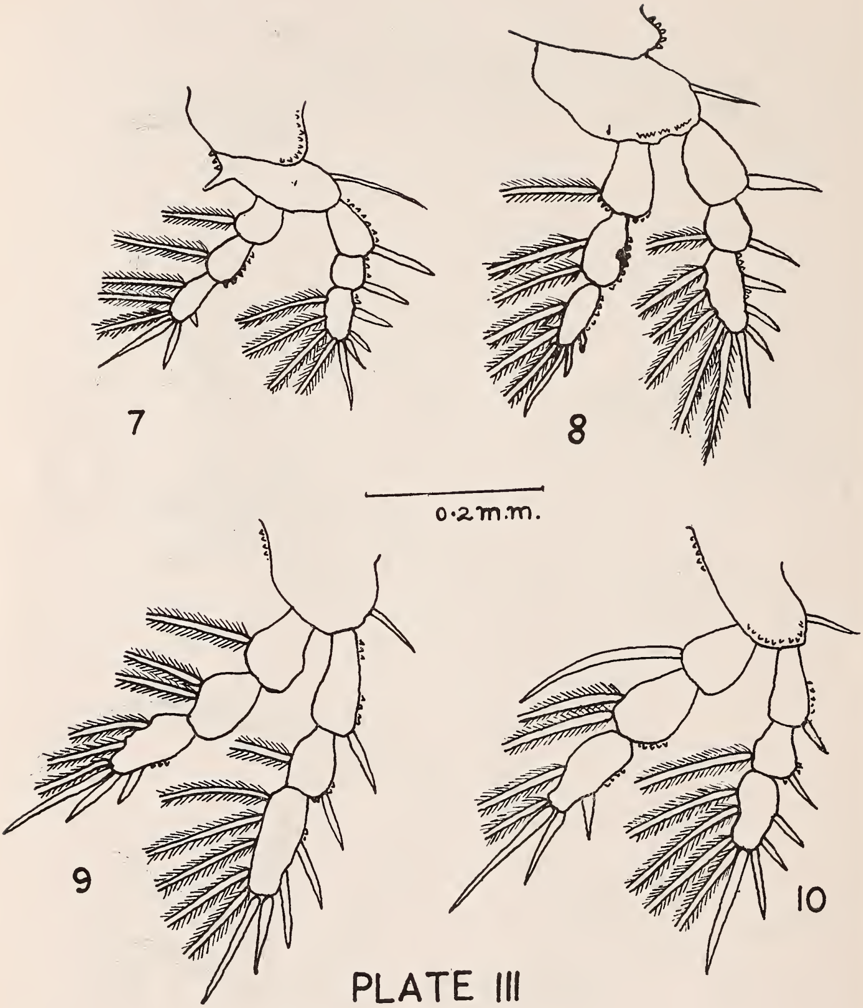


PLATE III

Leptinogaster stocki sp. nov.

Adult female. Fig. 7. First leg (x 400); Fig. 8. Second leg (x 400); Fig. 9. Third leg (x 400); Fig. 10. Fourth leg (x 240).

ments are also longer than wide and the last abdominal segment bears posteriorly two slender caudal rami. The caudal rami are slightly longer than the last abdominal segment. The caudal ramus is elongate and slender and bears a lateral seta, a little less than half way along its outer edge, a subterminal outer seta and three terminal setae, the middle one being the longest. There is a slender seta present on the middle distal position of the ramus. There is a group of spinules on the outer edge near the base of the ramus.

The first antenna (Fig. 2) is six jointed, the first segment the smallest and the second the longest. There are several setae on the segments as shown in the figure.

The second antenna (Fig. 3) is four jointed, the first segment with a seta at the distal end, the second segment bears a seta and group of spinules at the inner anterior end. The third segment with a row of spinules on the inner side and two recurved spines, one short and another stout, at the distal anterior end. The fourth segment is quadrate bearing three long setae and one short seta.

The mandible (Fig. 4) consists of a single segment and bears at the terminal end a spine, a plumose seta and a unilaterally serrated spine.

The maxillule (Fig. 5) is unsegmented, quadrate, bearing four setae, two distal and one on either side.

The maxilla (Fig. 6) has a broad basal segment with row of spinules at the posterior end and a large recurved stout spine with a small seta at the base.

The maxillipeds are absent.

Rami of the legs 1-4, three segmented with spines and setal formula as follows:

	Leg 1		*Leg* 2		*Leg* 3		*Leg* 4	
	Ex.	En.	Ex.	En.	Ex.	En.	Ex.	En.
1st Seg.	1:0	0:1	1:0	0:1	1:0	0:1	1:0	0:1
2nd Seg.	1:1	0:1	1:1	0:2	1:1	0:2	1:1	0:2
3rd Seg.	4:4	3:3	4:5	3:3	4:5	3:3	4:4	3:2

Leg 1. (fig. 7):– Coxopodite with a row of spines at the outer angle. Basipodite with an inner spine and an outer seta. There is a row of small spines at the base of the inner spine. The terminal segment of the exopod with four spines and four setae. The last endopodite segment bears three spines and three setae.

Leg 2 (Fig. 8):– The coxopodite with a group of spines at the outer angle. The basipodite with a seta on the outer edge and a row of spines terminally. Last exopodite segment with four spines and five setae instead of four as in 1st leg.. The last endopod segment with three spines and three setae.

Leg 3 (Fig. 9):– The basipodite with a seta on the outer edge and a row of spinules on the inner edge. The second segment of the endopod bears two setae and the last has three spines and three setae. The last exopodite segment bears four spines and five setae.

Leg 4 (Fig. 10):– Leg four is similar to leg three except that the last segment of the endopod bears three spines and two setae instead of three as in leg three. The last exopodite segment bears four spines and four setae instead of five as in leg three.

Leg 5 (Fig. 11):– Consists of two segments the first bearing on its outer edge a single long and slender seta and a row of spinules at the base of it. The second segment is more elongated than the first and bears on the outer edge a seta with a group of spinules at its base and two terminal seta and a stout slightly curved spine with spinules at their basis. There are two rows of spinules on the inner edge of the second segment.

Description of the adult male:

Body form (Fig. 12) as in the female. Length of the body excluding the caudal setae 2.60 mm greatest with 0.75 mm. The urosome six segmented. The genital segment slightly wider than long and is oval in shape. The next two segments are each as long as the genital segment and the last two slightly smaller in length. The genital segment bears on either side two elongated setae at the postero-lateral angles. There is a row of spines at the base of the seta.

The first antenna, second antenna, mandible, maxillule and the maxilla as in the case of female. The maxilliped (Fig. 13) four jointed, the first segment without any seta. The second also without a seta but having rows of spines on the inner side which is considerably elevated, the third segment very short and the fourth a long terminal claw bearing a single inner seta.

Spine and setal formula of legs 1-4 as in female Leg 5 similar to that of female except instead of two rows of spinules on the inner edge of the second segment there are two patches of spinules on the same side.

Remarks:

The genus *Leptinogaster* was created by Pelseneer (1928)[1] to accommodate the species *pholadis*. The number of species so far recorded under the genus *Leptinogaster* Pelseneer is as follows:

1) *Leptinogaster pholadis* Pelseneer
2) *Leptinogaster histrio* (Pelseneer)
3) *Leptinogaster major* (Williams)
4) *Leptinogaster inflata* (Allen)

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[1] PELSENEER, P. (1928): Copepods parasites de Mollusques. *Ann. Soc. Rav. zool. Belg.* *59*:33-49.

5) *Leptinogaster scobina* (Humes & Cressy)
6) *Leptinogaster dentata* (Humes & Cressy)

Leptinogaster stocki differs from *L. inflata* and *L. histrio* in not having an inflated metasome in the adult females. It differs from *L. pholadis* in having two spines on the third segment of the second antenna instead of one and in the different shape of the second segment of the male maxilliped. It differs from *L. major* in the less elongate fifth leg in female and different position of the outer edge spine on the second segment of the fifth leg. It differs from *L. scobina* and *L. dentata* in having spines and setae on the terminal segment of the exopod of the fourth leg instead of six. Apart from these, the species differs from all other species in having two setae instead of one on the second endopod segment of the fourth leg.

The genus *Leptinogaster* Pelseneer is being recorded in Indian waters for the first time. After the key given by Bocquet & Stock (1958)[1] three more species have been added under the genus *Leptinogaster* Pelseneer and therefore an up-to-date key for the identification of all the species is given below:

Key to the identification of species of *Leptinogaster* Pelseneer based on female specimens

1 Metasome in the adult female inflated......................3
2 Metasome in the adult female not inflated...................5
3 Caudal rami longer than the anal segment.....*L. inflata* (Allen)
4 Caudal rami shorter than the anal segment..*L. histrio* (Pelseneer)
5 Second endopod segment of the 4th leg with one seta.........7
6 Second endopod segment of the 4th leg with two setae..........
.... *L. stocki* sp. nov.
7 Third segment of the second antenna with two spines........9
8 Third segment of the second antenna with one spine..........
.... *L. pholadis* (Pelseneer)
9 Terminal segment of the exopod of the 4th leg with 6 spines and
setae 11
10 Terminal segment of the exopod of the 4th leg with 8 spines and
setae .... *L. major* (Williams)
11 Spines on the 3rd segment of the 2nd antenna claw like........
.... *L. dentata* (Humes & Cressy)
12 Spines on the 3rd segment of the 2nd antenna not claw like.....
.... *L. scobina* (Humes & Cressy)

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[1] Bocquet, C. & Stock J. H. (1958): Copepodes parasites d'invertebres des cotes da la Manche. IV Sur lestrois genres synonymes de copepodes cyclopoider, *Leptinogaster* Pelseneer, *Strongylopleura* Pelseneer, et *Myocheres* Wilson (Clausidiae). *Arch. Zool. Exp. Gen.* *96*:71-79.

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Records and observations on bats of Himalayan region of Uttar Pradesh and West Bengal, India[1]

BY

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During a survey of haematophagous arthropods in the Himalayan region of Uttar Pradesh and West Bengal between November 1966 and August 1970, 362 specimens of bats were collected for ectoparasitic search. These specimens represent 15 genera and 20 species. Additional geographical and ecological ranges for some species are recorded. Notes on distribution, reproduction and general natural history are presented for some of the species.

This paper presents data on bats collected in the Himalayan region of Uttar Pradesh and West Bengal by me intermittently between November 1966 and August 1970 during a haematophagous arthropod survey. A total number of 362 specimens representing 15 genera and 20 species was collected. This included 14 of the 26 species recorded from this area in the Checklist by Ellerman & Morrison-Scott (1951), two species recorded later on (Bhat, 1967, 1968) and 4 additional species. Representative specimens of each species are preserved either as dry skins and skulls or as wet specimens in formalin.

Additional notes on distribution, reproduction and general natural history are given for some of the species.

COLLECTION LOCALITIES

Brief description of the collection localities are given below. The altitudes in many instances are approximate. The area has diverse

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[1] Accepted May 15, 1972.

geographical and ecological features represented by tropical, subtropical temperate and alpine zones.

Uttar Pradesh:

District: NAINI TAL:– 1) *Bilaspur* near Bhim Tal (1380 m), subtropical zone; 2) *Dugada* (680 m), Balya valley, tropical zone; 3) *Garjia* (460 m), Kosi valley, tropical zone; 4) *Haldwani* (430 m), below foot hills in Bhabar, tropical zone; 5) *Ramnagar* (350 m), below foot hills in Bhabar, Kosi valley, tropical zone; 6) *Ranibag* (620 m), Balya valley, tropical zone.

District: ALMORA:– 7) *Arey* (770 m), near Bageshwar, Sarju valley, tropical zone; 8) *Bageshwar* (770 m), Sarju valley, tropical zone; 9) *Chalthi* (620 m), Ladhiya valley, tropical zone; 10) *Dhakuri* (2620 m), western slope of the Dhakuri Binayak range, Pindar valley, upper temperate zone; 11) *Dwali* (2770 m), Pindar valley, temperate zone; 12) *Kapkot* (1140 m), Sarju valley, subtropical zone; 13) *Kataithbara* (770 m), near Bageshwar; 14) *Katarmal* (1380 m), near Almora, Kosi valley, lower temperate zone; 15) *Khati* (2300 m), Pindar valley, upper temperate zone; 16) *Loharkhet* (1960 m), Sarju valley, temperate zone; 17) *Phaltaniya* (770 m), near Bageshwar; 18) *Sukhidhang* (1380 m), lower temperate zone.

District: PITHORAGARH:– 19) *Aat* (920 m), near Thal, Ramganga valley, subtropical zone; 20) *Dharchula* (920 m), Kali valley, subtropical zone; 21) *Dummer* (1540 m), Gori valley, temperate zone; 22) *Girgaon* (2000 m), on southern face of Kalamundi ridge, temperate zone; 23) *Khela* (1540 m), near Tawaghat, lower temperate zone; 24) *Kotera* (920 m), near Dharchula, subtropical zone; 25) *Kuity* (1380 m), near Tejam, subtropical zone; 26) *Lilam* (2000 m), Gori valley, temperate zone; 27) *Martoli* (3380 m), Gori valley, alpine zone; 28) *Milam* (3540 m), Gori valley, alpine zone; 29) *Patet* (920 m), near Thal, Ramganga valley, subtropical zone; 30) *Tawaghat* (1140 m), Dhauli valley, subtropical zone; 31) *Tejam* (1080 m), Ramganga valley, subtropical zone; 32) *Thal* (920 m), Ramganga valley, subtropical zone.

District: PAURI:– 33) *Dalmisain* (610 m), Kho valley, tropical zone; 34) *Dungripanth* (610 m), Alakananda valley, tropical zone; 35) *Narkota* (610 m), Alakananda valley, tropical zone; 36) *Raitoli* (610 m), Alakananda valley, tropical zone; 37) *Srinagar* (550 m), Alakananda valley, tropical zone.

District: CHAMOLI:– 38) *Didoli* (770 m), near Sonla, Alakananda valley, subtropical zone; 39) *Dogalbita* (2370 m), Nagnath hill range, temperate zone; 40) *Guliyo* (1230 m), near Gopeshwar, subtropical zone; 41) *Gwaldam* (200 m), Pindar valley, temperate zone.

District: TEHRI:– 42) *Ghonti* (920 m), Bhillangana valley, subtropical zone.

District: DEHRA DUN:– 43) *Dehra Dun* (610 m), tropical zone; 44) *Ramgarh* (600 m), tropical zone; 45) *Sahasradhara* (770 m), tropical zone; 46) *Sahaspur* (600 m), tropical zone; 47) *Satyanarayan* (340 m), tropical zone.

West Bengal:

District: DARJEELING:– 48) *Tashiding* (550 m), Tista river valley, tropical zone.

District: JALPAIGURI:– 49) *Chunabhatti* (200 m), Lish river basin, tropical zone.

In addition to these localities attempts had been made to collect bats at a number of other localities, but with negative results.

RECORDS AND NOTES ON SPECIES

Rousettus leschenaulti Desmarest, 1820
(Fulvous Fruit Bat)

Specimens collected: Total 74 (45 ♂♂, 27 ♀♀, 2 sex unrecorded). 2 ♂♂, 3 ♀♀ (1 juvenile), Dungripanth, 18 May '67; 1 ♂ 1 sex unrecorded, Narkota, each on 20 and 21 May '67; 2 ♂♂, 1 ♀, Raitoli, 23 May '67: 5 ♂♂, Dugada, 8 Sept. '67; 1 ♂, 1 ♀, Patet, 11 Sept. '67; 5 ♂♂, Tejam 13 Sept. '67; 6 ♂♂, 9 ♀♀, Kapkot, 30 Sept. '67; 1 ♀ (juvenile), Srinagar, 24 Oct. '67; 1 ♀, Sahasradhara, 31 Oct. '67; 4 ♂♂, Dalmisain, 12 Nov. '67; 2 ♂♂, Phaltaniya, 6 May '68; 2 ♂♂, Kataithbara, 7 May '68; 2 ♀♀, Kataithbara, 8 May '68; 1 ♂, 2 ♀♀, Thal, 5 Aug. '70; 12 ♂♂, 3 ♀♀, Thal, 7 Aug. '70; 2 ♂♂, 4 ♀♀, 1 baby, Aat 9 Aug. '70.

Notes: Specimens were collected in mist nets set between fruit trees, mainly bananas, near the cultivations in tropical and subtropical zones. Two juveniles were collected, one each in May and October. A female collected in August was carrying a baby with eyes not yet opened. The findings indicate the possibility of two breeding seasons for the species in the present area, one each in March and August, as recorded by Brosset (1962) in Western India.

Cynopterus sphinx Vahl, 1797
(Short-nosed Fruit Bat)

Specimens collected: Total 103 (45 ♂♂, 57 ♀♀ and 1 sex unrecorded). 2 ♀♀, Dugada, 25 Feb. '67; 1 ♂, 2 ♀♀, Dugada, 26 Feb. '67; 1 sex not recorded, Chalthi, 6 Mar. '67; 2 ♂♂, 1 ♀, Dharchula, 17 Mar. '67; 1 ♂, 3 ♀♀, Dharchula, 18 Mar. '67; 1 ♂, Kotera, 19 Mar. '67; 1 ♂, 2 ♀♀, Kataithbara, 23 Mar. '67; 2 ♀♀, Arey, 24 Mar. '67; 4 ♂♂, 3 ♂♂, Dugada, 8 Sept. '67; 1 ♀, Tejam, 13 Sept. '67; 1 ♂, Dehra Dun, 28 Oct. '67; 1 ♀, Ramgarh, 29 Oct. '67; 1 ♀, Dalmisain, 12 Nov. '67; 2 ♂♂, 2 ♀♀, Dalmisain, 13 Nov. '67; 2 ♂♂, 1 ♀, Garjia, one each on 16, 18 and 19 Nov. '67; 1 ♂, 3 ♀♀, Bilaspur

23 Nov. '67; 7 ♂♂, 3 ♀♀ and 1 ♀, Dugada, respectively on 28 and 29 Nov. '67; 2 ♀♀, Sahaspur, 2 Apr. '68; 1 ♂, 1 ♀, Didoli, 24 Apr. '68; 1 ♂, 4 ♀♀, Dugada, 3 May '68; 2 ♂♂, 1 ♀, Bageshwar, 5 Mar. '68; 5 ♂♂, 7 ♀♀, Tashiding, between 17 and 19 Mar. '69; 10 ♂♂, 13 ♀♀, Chunabhatti, between 24 and 28 Mar. '69; 2 ♂♂, 1 ♀, Dugada, 2 May '69; and 1 ♂, Thal, 5 Aug. '70.

Notes: Collected in mist nets set between fruit trees, mainly bananas, near cultivation in tropical and subtropical zones.

Sphaerias blanfordi Thomas, 1891
(Blandford's Fruit Bat)

Specimens collected: Total 40 (21 ♂♂, 17 ♀♀, 2 babies and 1 sex unrecorded) in addition to 51 specimens already reported (Bhat 1968). 1 ♂, 1 ♀, Sukhidhang, 4 Mar. '67; 1 sex not recorded, Dharchula, 17 Mar. '67; 1 baby born in mist net, mother already recorded (Bhat 1968), Dummer, 25 Sept '67; 1 ♀ plus baby and 3 ♀♀, Khela, respectively on 14 and 15 May '68; 1 ♀, Tawaghat, 16 May '68; 8 ♂♂ and 2 ♀♀, 4 ♂♂, and 2 ♀♀, 2 ♂♂ and 3 ♀♀, 4 ♂♂ and 1 ♀, 1 ♂ and 1 ♀, 1 ♂ and 1 ♀, Dogalbita, respectively on 10 and 11 May '69, and 8, 9, 11, and 12 July '70.

Notes: Collected in mist nets set between fruit trees (mainly bananas) near cultivation and forests in subtropical and temperate zones. The presence of a baby and juveniles in September indicates the month being breeding period. Collection of one baby in May and a number of young males in July at Dogalbita indicates a possibility of having a second breeding season in May.

Eonycteris spelaea (Dobson, 1871)
(Dobson's Long-tongued Fruit Bat)

Specimens collected: Only one young male was collected from Thal on 5 May '70, since the species was first recorded in the area on the basis of 7 specimens (Bhat 1967).

Notes: Collected in mist net set between banana trees near cultivation in tropical and subtropical zones.

Megaderma spasma Linnaeus, 1758
(Malay False Vampire)

Specimen collected: 1 ♂, Chunabhatti, 28 Mar. '69.

Notes: Collected in mist net set near the Bungalow. Recorded from this part of country for the first time.

Megaderma lyra Geoffroy, 1810
(Indian False Vampire)

Specimens collected: 2 ♂♂, 1 ♀, Ranibag, respectively on 26 and 27 Aug. '70.

Notes: These specimens were trapped at 19.30 hrs. in mist nets set at Dak Bungalow.

Rhinolophus ferrumequinum Schreber, 1774
(Greater Horseshoe Bat)

Specimen collected: 1 ♀, Katarmal, 19 Aug. '70.

Notes: Trapped at 19.15 hrs. in mist net set on the door of an ancient sun-temple. The temple dome was used by the species as day roost along with *Hipposideros armiger.*

Rhinolophus affinis Horsfield, 1823

Specimen collected: 1 ♂, Bilaspur, 21 Apr. '67.

Notes: Trapped in mist net set between fruit trees.

Rhinolophus rouxi Temminck, 1835

Specimen collected: 1 ♀, Tashiding, 18 Mar. '69.

Notes: Trapped in mist net set between banana trees.

Rhinolophus pearsoni Horsfield, 1851

Specimen collected: 1 ♂, Narkota, 20 May '67.

Notes: Trapped in mist net set between banana trees.

Hipposideros armiger Hodgson, 1831
(Great Himalayan Leaf-nosed Bat)

Specimens collected: 3 ♂♂, 4 ♀♀, Katarmal, 1 ♀ on 18 and rest on 19 Aug. '70.

Notes: 1 ♂ and 2 ♀♀ specimens were collected in mist nets set along verandah of Dak Bungalow. The bats got trapped at 19.30 hrs., while entering the verandah which was being used as night roost. 2♂♂ and 2 ♀♀ were trapped in mist nets on the door of the temple. The temple was being used as day roost along with *Rh. ferrumequinum.*

Myotis siligorensis Horsfield, 1855

Specimens collected: Total 22 (6 ♂♂ and 16 ♀♀). 3 ♂♂, 6 ♀♀, Dwali, 2 ♂♂ and 5 ♀♀, and 1 ♂ and 1 ♀ respectively on 4 and 5 Oct. '67; 2 ♂♂, 10 ♀♀, Dogalbita, 2 ♂♂ and 9 ♀♀, and 1 ♀ respectively on 10 and 11 May '69; and 1 ♂ on 12 Jul. '70.

Notes: At both the places the species was using roof crevices as day roost. The specimens were collected by trapping in mist nets while they were emerging at dusk. They were also seen while returning to the roost in the morning about 30 minutes before sunrise.

Myotis myotis dobsoni Trouessart, 1878
(Large Mouse-eared Bat)

Specimen collected: 1 ♂, Katarmal, 18 Oct. '70.

Notes: Trapped in mist net while hunting near a Bungalow.

The specimens perfectly fits with the description of *Vespertilio murinus* of Blanford (1891) which is a synonym of *Myotis myotis* Borkhausen, 1797, according to Ellerman & Morrison–Scott (1951). Tate (1947) considers *Vespertilio dobsoni* Trouessart, 1878 (*Vespertilio murinoides* Dobson, 1873 and *V. blythi* of Wroughton) as a subspecies of *Myotis myotis* occurring in Himalayas. The identity of the specimen is based on the above reasons. The species is now recorded for the first time from Kumaon.

Nyctalus leisleri montanus Barret Hamilton, 1906
(Hairy-armed Bat)

Specimens collected: Total 2. 1 ♀, Dogalbita, 8 Jul. '70; 1 ♀, Katarmal, 18 Aug. '70.

Notes: Trapped in mist nets set in Bungalow premises.

Nyctalus noctula labiatus Hodgson, 1835
(Common Noctule)

Specimen collected: 1 ♂, Gwaldam, 13 Apr. '67.

Notes: Collected in mist net set in forest. The species has been known to occur in the adjacent areas. Recorded for the first time in the area.

Pipistrellus mimus mimus Wroughton, 1899
(Indian Pigmy Pipistrelle)

Specimens collected: Toatl 21 (6 ♂♂ and 15 ♀♀). 3 ♂♂, 13 ♀♀, Haldwani, 1 ♂ and 9 ♀♀ and 2 ♂♂ and 4 ♀♀ respectively on 27 and 28 Nov. '67; 3 ♂♂, 2 ♀♀, Satyanarayan, one each on 29 Jun. and 2 to 5 Jul. '70.

Notes: All the specimens were collected either by pulling them out with forceps from wall crevices or in mist nets at dusk while emerging from their day roosts in the roof crevices. Both the collections are from the tropical zone.

Pipistrellus babu Thomas, 1915

Specimens collected: Total 5 (1 ♂ and 4 ♀♀). 1 ♂, Sukhidhang, 2 Mar. '67; 1 ♀, Srinagar, 24 Oct. '67; 3 ♀♀, Ghonti, 16 Jan. '70.

Notes: Collected in mist nets set in Bungalow premises at dusk. Appears to be distributed in tropical, subtropical and lower temperate zones.

Barbastella leucomelas darjelingensis Hodgson, 1855

Specimen collected: 1 ♂, Kapkot, 30 Sept. '67.

Notes: Trapped in mist net set in wooded bungalow premises. The species has been known to occur in the neighbouring areas, but is recorded in the present area for the first time.

Scotophilus heathi Horsfield, 1831
(Greater Yellow Bat)

Specimens collected: Total 15 (7 ♂♂ and 8 ♀♀). 2 ♂♂, 3 ♀♀, Haldwani, 2 ♀♀ and 1 ♂ respectively on 28 and 30 Nov. '67; 1 ♂ and 1 ♀ on May '68. 5 ♂♂, 5 ♀♀, Ramnagar; 5 ♂♂ and 2 ♀♀, 2 ♀♀ and 1 ♀ respectively on 28, 29 and 30 Aug. '70.

Notes: Trapped in mist nets set in wooded premises of Bungalows while the bats were hunting. The species was found actively hunting within 10 feet from the ground between 19.00 to 20.00 hrs. Never met with in the hills.

Plecotus auritus homochrous Hodgson, 1847
(Long-eared Bat)

Specimens collected: Total 3. 1 ♀, Martoli, 18 Sept. '67; 2 ♂♂, Milam, one each on 29 and 30 May '68.

Notes: Specimen from Martoli was caught flying inside a deserted building and those from Milam in mist nets set in the open ground. A number of specimens were observed emerging from the crevices of slate-roofs just after dusk. Never encountered in lower elevations.

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Additions to the Flora of North Gujarat (Ahmedabad-Mehsana-Sabarkantha Districts)[1 & 2]

BY

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Several papers have been published on the flora of some parts of south and central Gujarat and Saurashtra. However, the information, available on the flora of north Gujarat through the works of Saxton & Sedgwick (1918), Saxton (1922) and C. K. Shah (1963), remains incomplete as many of the areas within the limits of north Gujarat are not yet botanical explored. Hence it was thought desirable to explore botanically as many areas of Mehsana and Sabarkantha districts as possible with a view to fill this lacuna. The present study was confined to Mansa, Mahudi, Lakroda, Pahada and Keshni in Mehsana district and Himatnagar, Idar, Khedbrahama, Vireshwar, Sarneshwar and Vijaynagar in Sabarkantha district. During the course of the intensive explorations of these areas from 1965 onwards, extensive collections were made. The total number of species so far reported from north Gujarat (excluding Lunawada which did not fall within the limits of north Gujarat even at the time of Saxton and Sedgwick) is 672 to which 8 cyperaceae have been added by C. K. Shah (1963). Almost all the plants listed by earlier workers have been collected by us. In addition, there are about 200 species in our collections, which are reported here for the first time from north Gujarat.[3] In the list cultivated plants are omitted unless they are naturalised or escapes.

Geographically Mahudi, Pahada and Lakroda are on the banks of river Sabarmati, Keshni on the bank of river Khari, whereas Himatnagar and Khedbrahama are situated on the banks of rivers Hathmati

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[2] Based on the Ph.D. Thesis accepted by Sardar Patel University.

[3] BHATT ET AL. (*Bull. Bot. Surv. Ind. 11*:311-321), published (1972) since this paper was prepared lists some of the species recorded by us—GLS.

and Harnav respectively. All the explored areas are well knit by State Transport Buses from Ahmedabad, plying at all seasons. Ahmedabad-Khedbrahama railway line also connects Ahmedabad, Himatnagar, Idar and Khedbrahama.

Total number of species now known from north Gujarat is nearly 880, indicating that the flora is quite rich. However, the vegetation of the areas explored is predominantly a scrub forest type but that of Vireshwar and Sarneshwar is a dry deciduous type with *Butea-Alangium* community as dominant. The forests in these areas are dense but *Tectona grandis* Linn. f. and *Terminalia crenulata* Roth are rather occasional.

For the details of nomenclature Santapau & Janardhanan (1967), Rau (1969) and Shah (1969) may be consulted. The species prefixed by an asterisk are not given in Cooke's Flora (1901-08).

Though we have collected plants from Mehsana and Sabarkantha districts, Ahmedabad district is also included in the title as there are some plants in the list from Ahmedabad, collected by Saxton and/or Sedgwick, but not listed by them. Further all the districts are adjacent.

LIST OF PLANTS

FUMARIACEAE

Fumaria indica Pugsley

PAPAVERACEAE

Papaver somniferum Linn.

BRASSICACEAE (CRUCIFERAE)

Brassica campestris Linn. *var.* **sarson** Prain

Lepidium sativum Linn.

Raphanus sativus Linn.

CAPPARACEAE

Cleome aspera Koen. ex DC.

C. monophylla Linn.

VIOLACEAE

Viola cinerea Boiss. *var.* **stockii** Beck. *forma* **kathiawarensis** Beck.

CARYOPHYLLACEAE

Spergula arvensis Linn.

PORTULACACEAE

Portulaca tuberosa Roxb.

Talinum portulacastrum (Forsk.) Aschers. & Schweinf.

MALVACEAE

Abelmoschus ficulneus (Linn.) Wt. & Arn.

A. manihot (Linn.) Medic.

Abutilon glaucum (Cav.) Sw.

Azanza lampas (Cav.) Alef.

Hibiscus hirtus Linn.

H. vitifolius Linn.

Senra incana Cav.

Sida acuta Burm. f.

S. glutinosa Cav.

S. rhombifolia Linn. *var.* **retusa** Mast.

TILIACEAE

Grewia damine Gaertn.

Grewia tiliaefolia Vahl

Triumfetta rhomboidea Jacq.

T. pentandra A. Rich.

LINACEAE

Linum usitatissimum Linn.

Oxalidaceae

Biophytum sensitivum (Linn.) DC.

Burseraceae

Commiphora wightii (Arn.) Bhand.
Garuga pinnata Roxb.

Rhamnaceae

Zizyphus horrida Roth.
Z. xylopyra Willd.

Vitaceae

Cissus quadrangularis Linn.
C. repanda Vahl

Papilionaceae

Alysicarpus rugosus DC. *var.* **minor** Prain
Clitoria biflora Dalz.
Crotalaria albida Heyne ex Roth
C. triquetra Dalz.
Dalbergia latifolia Roxb.
Desmodium laxiflorum DC.
D. neomexicanum A. Gray
Dolichos biflorus Linn.
***Lathyrus aphaca** Linn.
Medicago polymorpha Linn.
M. lacinitata All.
M. sativa Linn.
Phaseolus angularis (Willd.) Wt.
P. dalzelli Cooke
P. mungo Linn.
P. radiatus Linn.
Pueraria tuberosa (Roxb.) DC.
Rhynchosia aurea DC.
Sesbania cannabina (Retz.) Pers.
Smithia conferta Sm.
***Tephrosia hamiltonii** Drumm.
T. pauciflora Grah.
T. purpurea (Linn.) Pers.
Vigna capensis Walp.

Caesalpiniaceae

Bauhinia tomentosa Linn.
Cassia angustifolia Vahl
C. fistula Linn.
C. kleinii Wt. & Arn.
C. obtusifolia Linn.
C. sophera Linn.

Mimosaceae

Acacia ferruginea DC.
Albizzia odoratissima Bth.

Combretaceae

Anogeissus latifolia (Roxb.) Wall. ex Bedd.
Combretum ovalifolium Roxb.
Terminalia bellerica (Gaertn.) Roxb.

Lythraceae

***Ammannia desertorum** Blatt. & Hallb.

Cucurbitaceae

Solena heterophylla Lour.
Trichosanthes bracteata (Lam.) Voigt.

Apiaceae (Umbelliferae)

Centella asiatica (Linn.) Urb.
Trachyspermum stictocarpum *var.* **stictocarpum**

Rubiaceae

Adina cordifolia (Roxb.) Hook. f. ex Brandis
Ixora brachiata Roxb.
Xeromphis spinosa (Thunb.) Keay

Asteraceae (Compositae)

Acanthospermum hispidum DC.
Blumea bifoliata DC.
B. membranacea DC.
B. oxydonta DC.
Gnaphalium luteoalbum Linn.
Laggera alata (Don) Sch.-Bip. ex Oliver
L. aurita (Linn. f.) Sch.-Bip.
Launaea residifolia (Linn.) Druce
Pluchea wallichiana DC.
***Pulicaria crispa** Sch.-Bip.
Sonchus asper (Linn.) Hill.
S. brachyotus DC.

PLUMBAGINACEAE

Dyerophytum indicum (Gibs. ex Wt.) O. Ktze.

SALVADORACEAE

Azima tetracantha Lam.

APOCYNACEAE

Wrightia tomentosa Roem. & Schult.

ASCLEPIADACEAE

Pentatropis spiralis (Forsk.) Decne.

Tylophora fasciculata Buch.-Ham.

PERIPLOCACEAE

Hemidesmus indicus (Linn.) Schult.

LOGANIACEAE

Cynoctonum mitreola (Linn.) Britt.

GENTIANACEAE

Nymphoides cristatum (Roxb.) O. Ktze.

BORAGINACEAE

Heliotropium ellipticum Ledeb.

EHRETIACEAE

Cordia gharaf (Forsk.) Ehrenb. ex Asch.

CONVOLVULACEAE

Ipomoea coptica (Linn.) Roth

SCROPHULARIACEAE

Lindernia oppositifolia (Retz.) Muk.

L. verbenaefolia (Colsm.) Pennell

GESNERIACEAE

Didymocarpus pygmaea Cl.

BIGNONIACEAE

Tecomella undulata (Sm.) Seem.

ACANTHACEAE

Barleria cuspidata Heyne ex Nees

***B. prattensis** Sant.

Dipteracanthus patulus (Jacq.) Nees

Eranthemum roseum (Vahl) R. Br.

Justicia diffusa Willd.

J. heterocarpa T. Anders.

J. simplex D. Don

Lepidagathis cristata Willd.

VERBENACEAE

Gmelina arborea Roxb.

Lantana salvifolia Jacq.

LABIATAE

Acrocephalus indicus (Burm. f.) O. Ktze.

Leucas longifolia Benth.

L. zeylanica R. Br.

Salvia plebeia R. Br.

PLANTAGINACEAE

Plantago ovata Forsk.

***P. psyllium** Linn.

AMARANTHACEAE

***Achyranthes aspera** *var.* **prophyristachya** Hook. f.

Aerva sanguinolenta (Linn.) Bl.

Amaranthus hybridus Linn. ssp. **cruentus** (Linn.) Thell. *var.* **paniculatus** (Linn.) Hell.

A. tricolor Linn.

A. viridis Linn.

***Gomphrena celosioides** Mart.

CHENOPODIACEAE

Salsola baryosma (Roem. & Schult.) Dandy

POLYGONACEAE

Polygonum glabrum Willd.

ARISTOLOCHIACEAE

Aristolochia bracteolata Lam.

EUPHORBIACEAE

Baliospermum montanum (Willd.) Muell.-Arg.

Bridelia squamosa (Lam.) Gehrm.

***Dalechampia scandens** Linn. *var.* **cordofana** (Hochst. ex A. Rich.) Muell.-Arg.

Euphorbia chamaesyce Linn.
E. clarkeana Hook. f.
E. geniculata Orteg.
Jatropha curcas Linn.
Phyllanthus simplex Linn.
P. urinaria Linn.
Putranjiva roxburghii Wall.
Securinega virosa (Roxb. ex Willd.) Pax & Hoffm.

MORACEAE

Ficus amplissima Sm.
F. arnottiana Miq.

CANNABACEAE

Cannabis sativa Linn.

HYDROCHARITACEAE

Nechamandra alternifolia (Roxb.) Thw.
Ottelia alismoides (Linn.) Pers.

ZINGIBERACEAE

Curcuma inodora Blatt.

AMARYLLIDACEAE

Crinum pratense Herb.

HYPOXIDACEAE

Curculigo orchioides Gaertn.

DIOSCOREACEAE

Dioscorea hispida Linn.
D. pentaphylla Linn.

LILIACEAE

Asparagus gonoclados Baker
Chlorophytum tuberosum (Roxb.) Baker

ARECACEAE (PALMAE)

Borassus flabellifer Linn.
Calamus rotang Linn.
Phoenix sylvestris (Linn.) Roxb.

COMMELINACEAE

Commelina forskalaei Vahl
***C. kurzii** Clke.
***C. paludosa** Bl.
Cyanotis cristata Schult. f.

ARACEAE

Amorphophallus sp.
Pistia stratiotes Linn. *var.* **cuneata** Engl.
Sauromatum venosum (Ait.) Kunth

LEMNACEAE

Lemna paucicostata Hegelm.
Wolffia microscopica (Griff.) Kurz

NAJADACEAE

Potamogeton crispus Linn.
P. nodosus Linn.

ERIOCAULACEAE

Eriocaulon eleanorae Fyson

CYPERACEAE

***Cyperus alulatus** Kern
C. compressus Linn.
C. cyperioides (Linn.) O. Ktze.
Eriophorum comosum Wall. ex Nees
***Fimbristylis sieberriana** Kunth
Rhynchospora wightiana Steud.

POACEAE (GRAMINEAE)

Aristida setacea Retz.
Avena sativa Linn.
Cenchrus pennisetiformis Hochst. & Steud. ex Steud.
Crypsis schoenoides (Linn.) Lam.
Cymbopogon citratus (DC.) Stapf
***C. gidarba** (Ham. ex Hook. f.) Haines
C. martinii Wats.
***Cynodon barberi** Rang.
***Digitaria adscendens** H.B.K. ssp. **adscendens** *var.* **criniformis** Henr.
Echinochloa stagnina (Retz.) Beauv.
***Ischaemum goebelii** Hack.
***Setaria pallide-fusca** (Schum.) Stapf & C. E. Hubb.
Sorghum vulgare Pers.
Sporobolus piliferus (Trin.) Kunth
Triticum aestivum Linn.

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We are deeply grateful to late Dr. H. Santapau, and Prof. P. V. Bole of St. Xavier's College, Bombay for facilities to work in the Blatter Herbarium, Bombay. Sincere thanks are also due to Prof. G. T. Pandya for allowing us to consult the collections of Saxton and Sedkwick and Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Poona, for confirming the identifications of some grasses.

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Three new species of Aphelinidae (Hymenoptera : Chalcidoidea) parasitic on *Aonidiella orientalis* (Newst.) from India[1]

BY

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(*With fifteen text-figures*)

INTRODUCTION

The coccid *Aonidiella orientalis* (Newst.), an important pest of fruit trees, is parasitized by several species of chalcids. From India the following encyrtid and aphelinid parasites have been so far recorded:

Encyrtidae: 1. *Comperiella bifasciata* Howard, 1906
2. *Comperiella lemniscata* Compere & Annecke, 1961
3. *Comperiella unifasciata* Ishii, 1925
4. *Thomsonisca indica* Hayat, 1970
Aphelinidae: 5. *Aphytis chrysomphali* (Mercet, 1912)
6. *Aphytis lingnanensis* Compere, 1955
7. *Azotus qadrii* Agarwal, 1964
8. *Coccophagoides orientalis* (Agarwal, 1964)
9. *Marietta javensis* (Howard, 1907)
10. *Physcus reticulatus* Compere & Annecke, 1961
11. *Physcus* sp. (near *flaviventris* Howard)

In this paper three new species belonging to the aphelinid genera *Marlattiella* Howard, *Physcus* Howard, and *Ablerus* Howard are described. The genera *Marlattiella* and *Ablerus* are new records for India.

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Marlattiella Howard

Howard, 1907, *U. S. Dep. agric. Bur. Ent. Tech. Ser.* 12:73
Type species: *Marlattiella prima* Howard

Marlattiella maculata sp. nov.
(Figs. 1-3)

Female —

Length, 0.86 mm. Head whitish; epistoma, basal half of genal sulcus and an inverted 'Y' shaped patch on occiput above foramen brown. Antennae whitish except club which is brown on basal two-thirds and yellow on apical third. Thorax whitish with brown or dusky as follows: Centre of pronotum and propodeum except sides brown; three patches on anterior margin of mesoscutum and two patches on posterior fourth, two patches on anterior third and whole of posterior margin of scutellum dusky. Fore wings hyaline with a faint infuscated patch below marginal vein. Hind wings hyaline. Legs whitish. Gaster whitish with a dark brown patch on dorsum extending from base to level of cercal plates, sides and tenth tergum white.

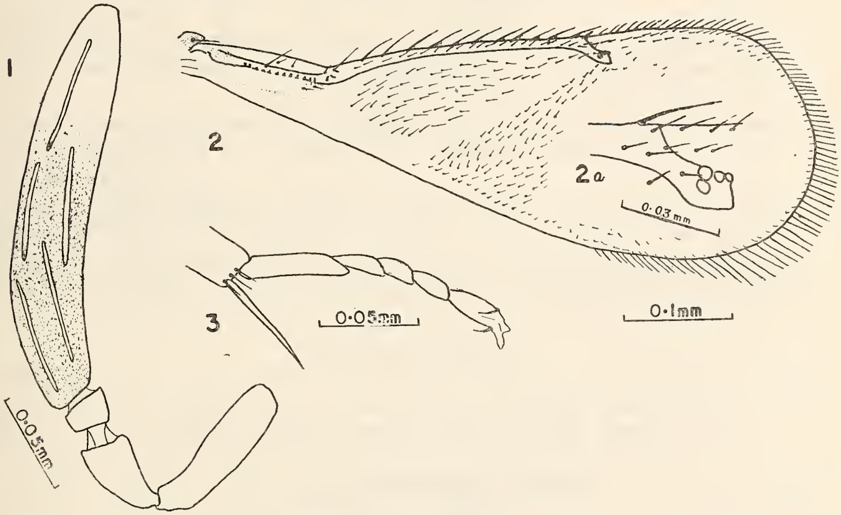

Fig. 1-3. *Marlattiella maculata* sp. n. ♀. 1. antenna; 2. fore wing; 2a. stigmal vein; 3. distal part of middle leg.

Head as wide as thorax; frontovertex width nearly one third head width (6.75:18), one and a half times as long as wide; eyes with short hairs; ocelli arranged in acute triangle, lateral ocelli removed from eye rim by one ocellus diameter and from occipital margin by two ocellar diameters. Proportions of antennal components as in Fig. 1.

Prontoum composed of two triangular plates joined in middle by a membrane, postero-lateral angles with a long seta; mesoscutum, parapsides and scutellum with 6, 2+2 and 4 setae respectively.

Fore wings a little less than three times as long as wide (20:7); marginal vein longer than submarginal vein (17.5:7.5), these veins with 12 and 1 setae; postmarginal vein absent; stigmal vein as in Fig. 2a; marginal fringe one fifth width of wing (Fig. 2). Hind wings six times as long as wide; marginal fringe as long as width of wing.

Tibial spur of middle leg (Fig. 3) a little longer than basitarsus.

Gaster slightly longer than thorax (25:23); ovipositor extends from second segment, exserted part one fifth length of gaster.

Male—Not known.

MATERIAL STUDIED: Holotype ♀, INDIA: Uttar Pradesh, Aligarh, ex *Aonidiella orientalis* (Newst.), on *Ficus* sp., 22.vii.1968, Coll. M. Hayat. Holotype will be deposited in the Zoological Survey of India, Calcutta.

Comments.—*M. maculata* can be easily separated from the other two known species by the following key characters:

1. Club about as long as scape; mesoscutum, scutellum and parapsides with 26, 4 and 1+1 setae respectively; submarginal vein with 2 setae.......... .... *secuda* Compere[3]
1. Club longer than scape, pedicel and funicle combined; mesoscutum, scutellum and parapsides with 6, 4 and 2+2 setae respectively; submarginal vein with 1 seta 2
2. General colour orange yellow; fore wings hyaline, speculum mesally bounded by about 40 setae, marginal fringe about one third of width of wing .... *prima* Howard
2. General colour whitish with dusky or brown patches, dorsum of gaster except sides and tenth tergum brown; fore wings with a faint infuscated patch below marginal vein, speculum mesially bounded by about 70 setae, marginal fringe one fifth of width of wing....*maculata* sp. nov.

Physcus Howard

Howard, 1895, *U. S. Dep. agric. Ent. Tech. Ser.* 1:43
Type species: *Coccophagus varicornis* Howard

Physcus aligarhensis sp. nov.
(Figs. 4-9)

Female—

Length, 0.83 mm. Head blackish brown; eye rim and frontovertex testaceous yellow. Thorax blackish brown with testaceous yellow portions as shown in Fig. 4 (unstippled areas). Gaster white with a longitudinal brown band on each side extending from base to cercal plates. Scape except apex brown, apex of scape and rest of antenna pale yellow. Wings hyaline. Legs pale yellow, marked with dusky as follows:

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[3] Rosen and De Bach (1970) consider it as a 'dubious species of *Aphytis*, possibly a "connecting link" between *Aphytis* and *Marlattiella*'.

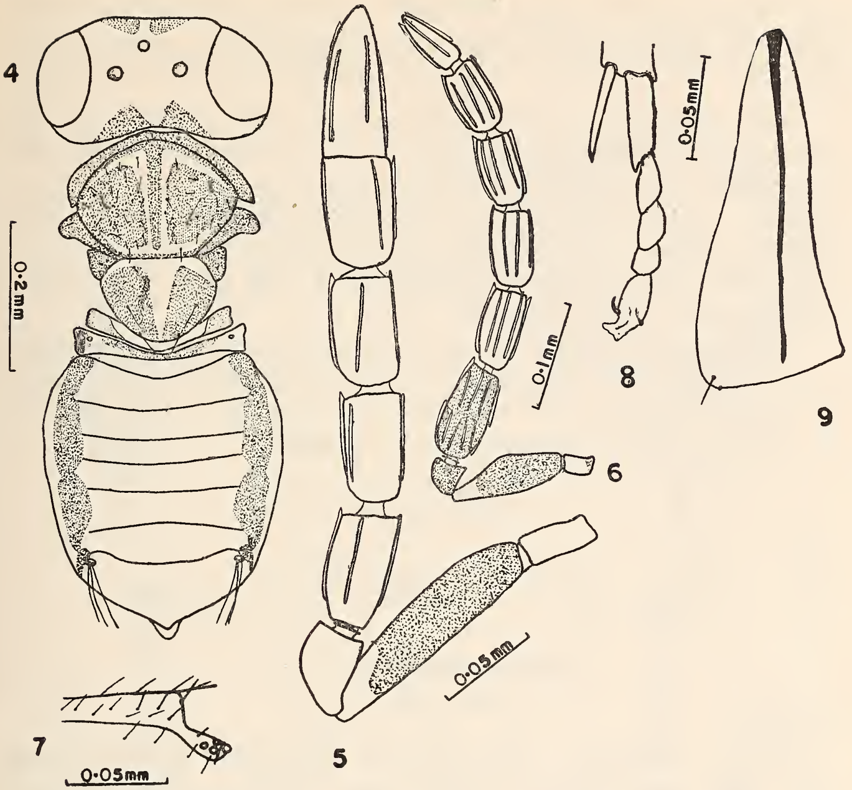

Fig. 4-9. *Physcus aligarhensis* sp. n. ♀, ♂. 4. entire female, antennae, wings and legs removed; 5. antenna, female; 6. antenna, male; 7. stigmal vein; 8. distal part of middle leg; 9. outer plate of ovipositor.

coxae, femora except distal ends and basal half of tibiae of fore legs; distal half of femora and basal half of tibiae of middle legs; apices of coxae, apices of femora and basal half of tibiae of hind legs.

Head broader than thorax (9:7.5); frontovertex about one half of head width; ocelli arranged in obtuse triangle; antennal sockets situated far above oral margin, their upper margins a little above an imaginary line drawn across lower eye margins. Proportions of antennal components as in Fig. 5.

Fore wings two and a half times as long as wide (22:9); submarginal vein as long as marginal vein, these veins with 8 and 9 setae; stigmal vein short (Fig. 7); postmarginal vein absent; length of marginal fringe one fifth width of wing. Hind wings six times as long as wide, marginal fringe shorter than wing width.

Tibial spur of middle leg as long as basitarsus (Fig. 8).

Gaster as long as thorax; outer plates of ovipositor (Fig. 9) with a submarginal ridge along dorsal margin; third valvulae one and a half times longer than tibial spur of middle leg; ovipositor not exserted.

Male—Essentially similar to the female except for the following differences:

Body completely blackish; scape except apex, pedicel and first funicle segment brown, rest of antenna yellow; proportions of antennal components as in Fig. 6.

MATERIAL STUDIED: Holotype ♀ : 2 ♀, 1 ♂, paratypes, INDIA: Uttar Pradesh, Aligarh, ex *Aonidiella orientalis* (Newst.), on *Ficus* sp. 18.vii.1968, Coll. M. Hayat. Material will be deposited in the Zoological Survey of India, Calcutta.

Comments—*P. aligarhensis* sp. n. comes closest to *P. flavoflagellatus* De Santis, 1940, but differs by the specific body colour, length of marginal fringe of both fore and hind wings, and in the male by the brown colour of the first funicle segment.

Ablerus Howard

Howard, 1894, *Insect Life* 7:7
Type species: *Centrodora clisiocampae* Ashmead

Ablerus aonidiellae sp. nov.

(Figs. 10-15)

Female—

Length, (excluding exserted part of ovipositor), 0.61 mm (0.09 mm). Head white; occiput blackish, shiny; malar space with a brown band extending from postgenae, passing below the eyes, and touching antennal sockets. Thorax and gaster dark brown with faint violet and greenish reflections. Dorsal surface of scape, basal two-thirds of pedicel, funicles I and III and club brownish; rest of antenna white. Fore wings infuscated with apical third hyaline. Hind wings hyaline. Legs: coxae except apices, fore and middle femora except base and apical half, hind femora except base and apex narrowly, fore and middle tibiae except base and apical half, hind tibiae except apex, and last tarsal segment of all legs brown; rest of parts white.

Frontovertex width one fourth head width (1:4), a third longer than its own width (3:2); ocelli in obtuse triangle, lateral ocelli near to eye rim and removed from occipital margin by one ocellus diameter; antennal sockets removed from facial margin by a distance equal to length of a socket; malar space as long as eye width; mandibles with two teeth and a dorsal truncation. Proportions of antennal components as in Fig. 10.

Thorax shorter than gaster (3:5); pronotum (Fig. 12) with anterior and posterior margins concave, each postero-lateral side with 2 brown setae; mesoscutum, axillae and scutellum with 4, 1+1 and 4 setae respectively; scutellum over twice wider than long (25:11); median length of propodeum a trifle over three times that of metanotum (13:4); mesopostphragma one-third length of gaster, its apex truncate.

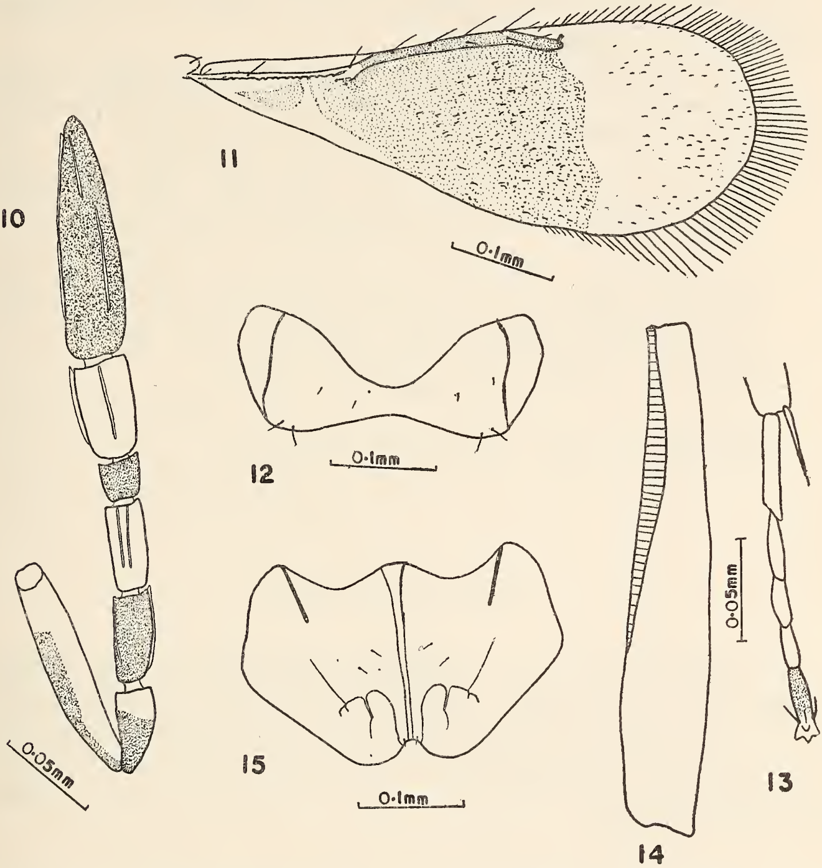

Fig. 10-15. *Ablerus aonidiellae* sp. n. ♀. 10. antenna; 11. fore wing; 12. pronotum; 13. distal part of middle leg; 14. outer plate of ovipositor; 15. subgenital plate.

Fore wings (Fig. 11) with submarginal vein longer than marginal vein, these veins with 2 and 4 setae; length of marginal fringe 1/3 width of disc. Hind wings six times as long as wide; marginal fringe as long as width of wing.

Tibial spur of middle leg shorter than basitarsus (Fig. 13).

Gaster longer than thorax; outer plates of ovipositor (Fig. 14) narrow, dorsal margin with an inflexion extending from base to two-thirds length of the plate; subgenital plate (Fig. 15) with a notch in middle of posterior margin, sides of notch followed by wavy ridges, mid-longitudinal groove and antero-lateral apodemes present; exserted part of ovipositor one third length of gaster.

Male—Not known.

MATERIAL STUDIED: Holotype ♀ : 2 ♀ , paratypes, INDIA: Uttar Pradesh, Aligarh, ex *Aonidiella orientalis* (Newst.), on *Psidium guajava* L., 12.ix.1969, Coll. M. Hayat. Material will be deposited in the Zoological Survey of India, Calcutta.

Comments—*A. aonidiellae* sp. n. can be easily separated from *A. clisiocampae* (Ashmead) and *A. magistrettii* Blanchard, to which it is most closely related, by the following key characters:

1. Marginal vein with 4 setae; apical one third of fore wing hyaline; length of marginal fringe one third width of wing. Hind wing with marginal fringe as long as width of wing. Basitarsi of all legs whitish.......... .... *aonidiellae* sp. n.
1. Marginal vein with 3 setae; apical one fourth of fore wing hyaline; length of marginal fringe 1/5 to 1/6 width of wing. Hind wing with marginal fringe shorter than width of wing. Basitarsi of all legs brown........ 2
2. Submarginal vein with 2 setae. Second tarsal segment of all legs whitish. Tibial spur of middle leg shorter than basitarsus.................... .... *magistrettii* Blanchard
2. Submarginal vein with 1 seta. Second tarsal segment of all legs brown. Tibial spur of middle leg as long as basitarsus...................... .... *clisiocampae* (Ashmead)

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Smithsonia (Orchidaceae), a new Genus from Western India[1]

BY

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(*With two plates*)

In his study on *Sarcochilus* R. Br. and *Pteroceras* Hassk., Holttum (Kew Bull. 14:263-276, 1960) doubted the generic status of two orchids described by Dalzell from Western India.

The first was described as *Micropera maculata* Dalz. This species was transferred to *Sarcochilus* R. Br. by Pfitzer, shifted to *Saccolabium* Bl. by J. D. Hooker and placed in *Gastrochilus* Don by Otto Kuntze. Holttum withheld his opinion with the remark "I would like to see fresh flowers of this species before assigning it to a genus."

The second plant was named *Micropera viridiflora* Dalz. This was transferred to *Saccolabium* by Lindley, to *Sarcochilus* by Cooke and to *Gastrochilus* by Santapau & Kapadia. While accepting the view of Santapau & Kapadia, Holttum observed "the lip of the species has a rather narrow spur in place of the wide sac of Malaysian species of *Gastrochilus*."

The plants described by Dalzell cannot be retained in *Micropera* Lindley as the type of the genus has itself been transferred to *Camarotis*. As Holttum points out, the name *Micropera* Lindl. has no status. These plants cannot be included in *Saccolabium* Bl. as this genus is characterised by the presence of a fleshy callus inside the spur cavity and by two, entire pollinia. Neither can they be assigned to *Sarcochilus* R. Br. which has four pollinia in two unequal pairs and a movable sac-like lip with a prominent callus inside the spur. They cannot be included in *Gastrochilus* Don which has a saccate-cupular, broad lip, a transverse fringed mid-lobe and 2, only slightly notched or indented pollinia.

Both *Micropera maculata* Dalz. and *M. viridiflora* Dalz.—fairly common plants in Western India—have pointed spurs devoid of septa,

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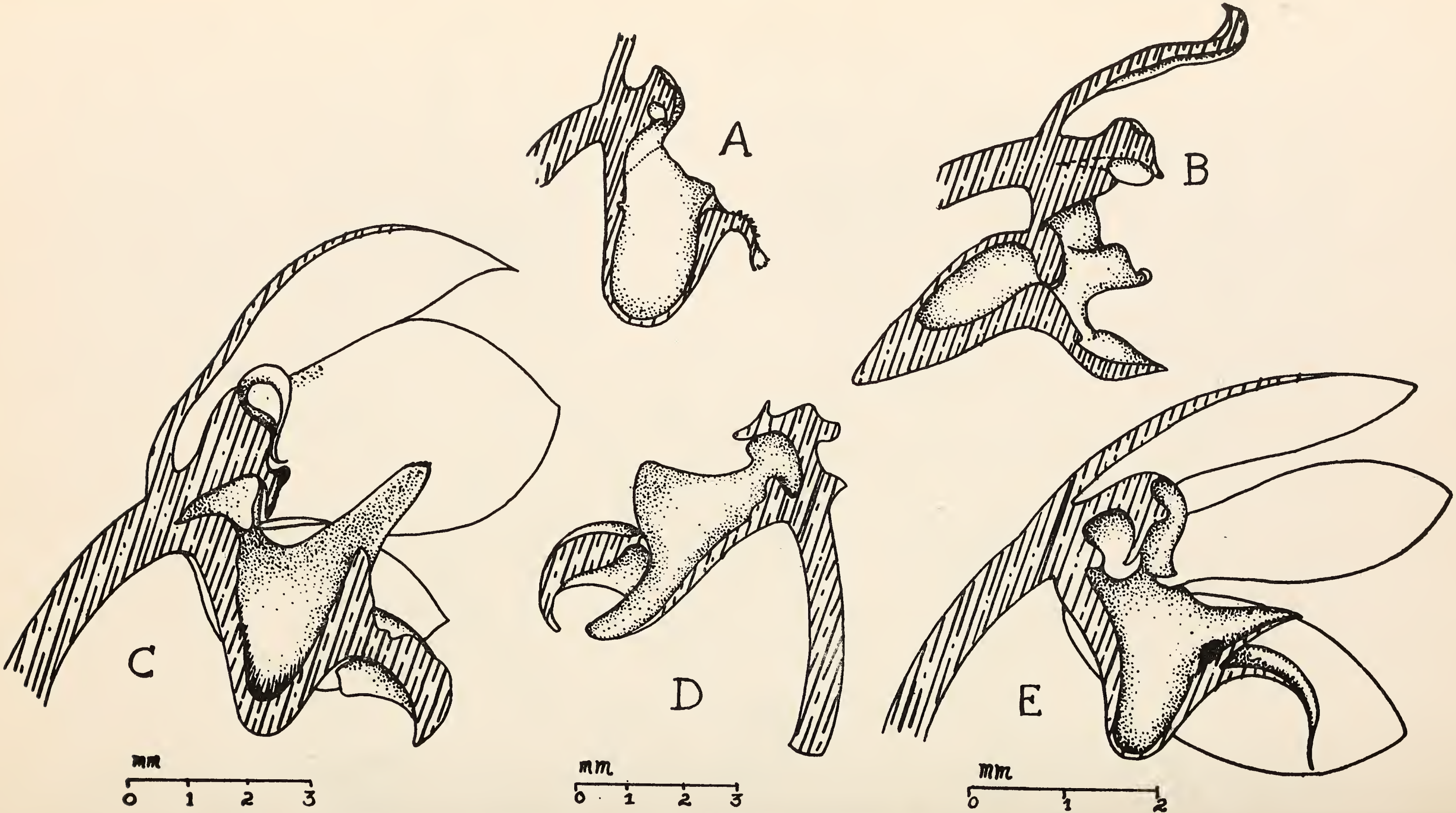
[1] Accepted May 25, 1972.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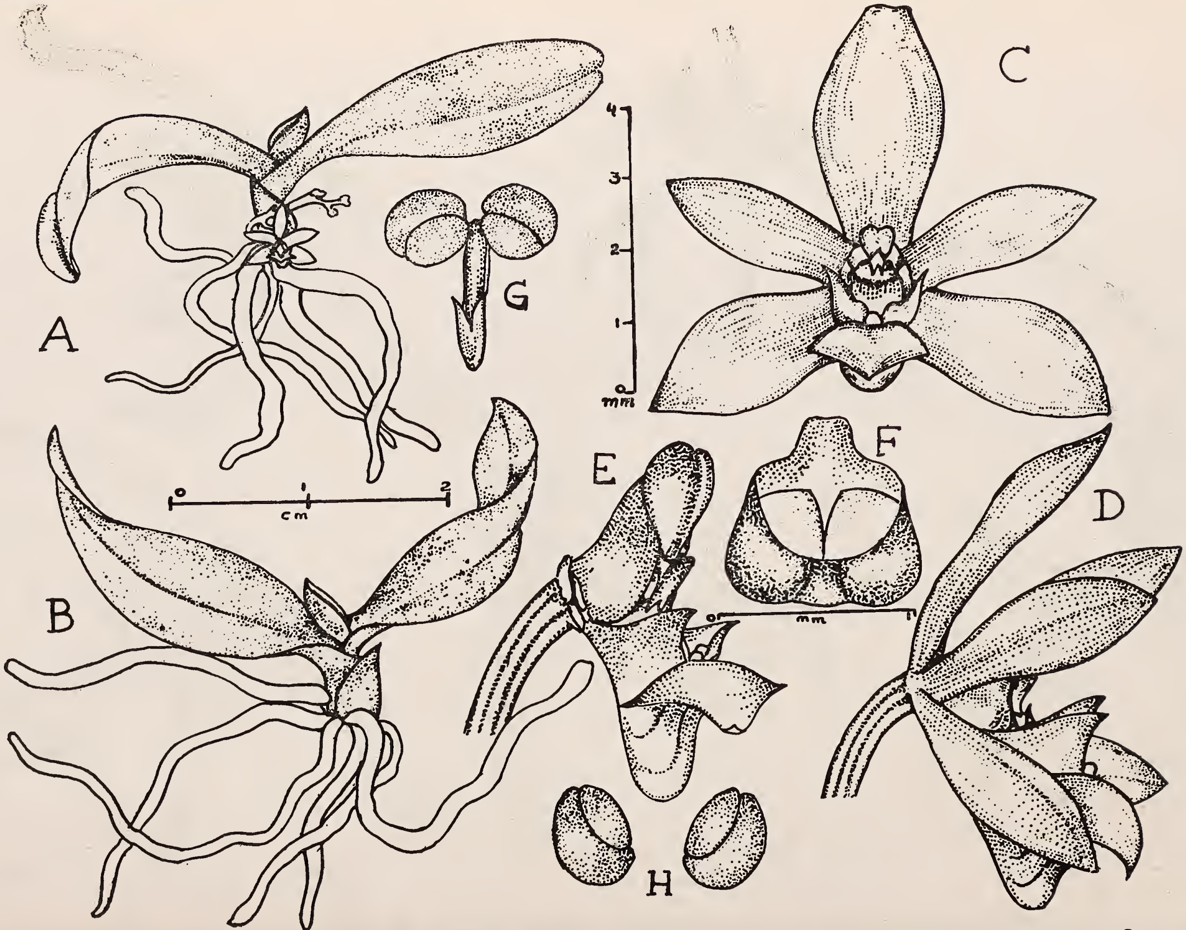
L. S. of flowers: A. *Gastrochilus calceolaris* Don (after Holttum); B. *Sarcanthus subulatus* (Bl.) Reich. f. (after Holttum); C. *Smithsonia maculata* (Dalz.) Saldanha: C. *Smith-*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Smithsonia straminea Saldanha: A-B Entire plants; C-D Two views of flower; E Column and lip; F Operculum G-H Pollinia.

calli or tongue-like projections within the spur cavity. The spur cavity is hairy in the former and glabrous in the latter. The pollinia are 2, deeply grooved and unequally lobed. I have collected a third orchid with somewhat similar spur and pollinia. These three form a distinct genus that can be segregated from the other genera in this group. I am naming this genus *Smithsonia* in honour of James Smithson.

Smithsonia gen. nov.

Pertinet ad tribum *Sarcanthinearum* et distinguibile calcare amovibile, attenuato, non-septato, intus glabro vel pubescente, sine callositatibus distinctis vel projecturis liguliformibus. Labellum 3-lobatum, lobis lateralibus erectis et lobo mediano transversali plus minusve calcar obtegente. Pollinia 2, profunde in lobis inaequalibus sulcata. Stipes indivisus, exilis, ad apicem glandula bifida. Rostellum bifidum in directionem calcaris productum.

Differt a *Saccolabio* calcare attenuato, sine septis vel callositatibus et polliniis profunde sulcatis. Differt etiam a *Sarcochilo* absentia in calcare prominentiarum numeroque polliniorum. Distinguibile a *Gastrochilo* calcaris forma et polliniorum sulco.

Smithsonia gen. nov.

The genus belongs to the tribe *Sarcanthineae* and is characterised by an immovable, attenuated, non-septate spur that may be glabrous or hairy within and is devoid of callus pads or tongue-like projections. Lip 3-lobed, with lateral lobes erect and a transverse central lobe more or less covering the spur. Pollinia 2, deeply furrowed into 2 unequal lobes. Stipe undivided, slender with a bifid gland at tip. Rostellum bifid pointing towards spur.

Differs from *Saccolabium* by the attenuated spur which is devoid of septa and by the deeply furrowed pollinia. It differs from *Sarcochilus* by the absence of projections in the spur and by the number of pollinia. It is distinguished from *Gastrochilus* by the shape of the spur and the groove of the pollinia.

The following three species are included in the genus.

Smithsonia straminea sp. nov. Generis typus

Planta epiphytica. Radices 3-6 ex basi caulis orientes, usque 10 cm longae, 0.4 cm diam. Caulis brevissimus. Folia 2-4, disticha, coriacea, elliptico-oblonga, paulo canaliculata, ad apicem integra vel bilobata, versus basim attenuata articulata et imbricata, usque 0.7 × 2 cm. Racemi 1-2, generatim infrafoliares foliisque breviores, 4-8 floribus. Flores diuturni, bracteati, sessiles, 0.5 cm diam.; sepala subsimilia, obovata, straminea maculisque rubris. Labellum amovibile, calcaratum, 3-lobatum. Calcar roseum, subconicum, rectum, nec callositatibus nec projecturis praeditum, 3-4 mm longum; lobi laterales albi, erecti, acuti, sicuti calcaris marginis prolongationes; lobus medianus albus, transversalis, arcuatus, integer, lateraliter breviter obtusus, prope cum calcare juncturam paulo torulosus. Columna rosea, brevis, cum calcaris margine conjuncta. Operculum stramineum. Pollinia 2, profunde sulcata. Stipes simplex, angustatus ad apicem glandula ligulata. Rostellum 2-lobatum, in directionem calcaris productum. Capsula elliptico-obovata, prominenter costata, 0.5 × 1.5 cm.

A *S. viridiflora* statura coloreque florum, forma calcaris labellique loborum differt. A *S. maculata* plantae statura, inflorescentiae longitudine, forma staturaque florum facile distinguibilis.

Smithsonia straminea sp. nov.

An epiphyte. Roots 3-6, arising from the base of the stem, up to 10 cm long and 0.4 cm in diam. Stem very short. Leaves 2-4, distichous, coriaceous elliptic-oblong and slightly channelled, imbricating, bilobed or entire at apex, narrowed and articulated at base. Racemes 1-2, generally below and shorter than the leaves, 4-8 flowered. Flowers lasting for several days, bracteate, sessile, 0.5 cm across. Sepals straw-coloured with red spots, subsimilar, obovate, 1.5 × 3 mm; petals slightly smaller and narrower, yellow with red spots. Lip immovable, spurred, 3-lobed. Spur pink, sub-conical, straight, without calli or projections within, 3-4 mm long; lateral lobes white, erect, acute, as prolongations of the rim of the spur; mid-lobe white, transverse, arching downwards, entire, shortly obtuse on the sides, with a small knob near junction with the spur. Anther cap yellowish. Pollinia 2, deeply cleft. Stipe single, narrow, ending in a tongue-like gland. Rostellum 2-lobed, pointing towards spur. Capsule elliptic-obovate, strongly ribbed, 0.5 × 1.5 cm.

Differs from *Smithsonia viridiflora* in size and colour of flowers, shape of the spur and lobes of the lip. It is easily separated from *S. maculata* by the size of the entire plant, length of the inflorescence and by the shape and size of the flowers.

Holotype: *Saldanha* 13361 collected at Devalkere in Hassan District, Mysore State on 14 April 1969 and preserved in the Herbarium of St. Joseph's College, Bangalore. *Paratypes*: HFP 1608 and 1675 collected in the same district in April-May 1971.

Smithsonia maculata (Dalz.) comb. nov.

Micropera maculata Dalzell, Hooker's J. Bot. 3:282. 1851.
Sarcochilus maculatus (Dalz.) Pfitzer, Vergl. Morph. Orch. 15. 1881.
Saccolabium maculatum (Dalz.) J. D. Hooker, Fl. Brit. India 6:64. 1890.
Gastrochilus maculatus (Dalz.) O. Kuntze, Rev. Gen. Pl. 2:661. 1891; Santapau & Kapadia, J. Bombay nat. Hist. Soc. 59:841. 1963.

Smithsonia viridiflora (Dalz.) comb. nov.

Micropera viridiflora Dalzell, Hooker's J. Bot. 3:282. 1851.
Saccolabium viridiflorum (Dalz.) Lindley, J. Linn. Soc. Bot. 3:36. 1858.
Sarcochilus viridiflorus (Dalz.) Cooke, Fl. Pres. Bombay 2:697. 1907. (non Hooker, 1890).
Sarcochilus dalzellianus Santapau, Kew Bull. 1948:498. 1949.
Gastrochilus dalzellianus (Sant.) Santapau & Kapadia, J. Bombay nat. Hist. Soc. 59:842. t. 52A. 1963.

KEY TO THE SPECIES

A Inflorescence longer than the leaves........................ *S. maculata*
AA Inflorescence shorter than the leaves
B Midlobe of lip overhanging spur completely, prolonged into triangular, acute lateral wings. Fls. greenish-white, 1-1.5 cm wide .... *S. viridiflora*
BB Midlobe of lip not overhanging spur completely; lateral wings short, obtuse. Flowers straw-coloured spotted with red, 0.5 cm wide .... *S. straminea*

ACKNOWLEDGEMENTS

I am grateful to Prof. R. E. Holttum and Dr. Dan H. Nicolson for their valuable suggestions and to the Smithsonian Research Foundation for support.

The Avifauna of introduced Eucalyptus plantations in Maharashtra[1]

BY

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A study of the avifauna of two small introduced Eucalyptus plantations indicated extensive changes in species composition at the end of the monsoon season, and changes in resident species with advancing stages of plantation development. The birds seemed to be attracted to the outer areas of the plantation which offer more diverse vegetation. These plantations provide an opportunity to study the effects of introduced vegetation on local fauna.

INTRODUCTION

Small Eucalyptus plantations, started by the Indian Government to control soil erosion, provided rare opportunities to study the wildlife of isolated, introduced, islands of vegetation. Awsari and Pachgaon are two such plantations, situated on the leeward side of the Western Ghats approximately 170 kilometres east of Bombay. Eucalyptus has been introduced extensively throughout the sub-continent to start new plantations. In this area, plantations appeared to be widely scattered, separated by approximately 80 or 90 kilometres. These small plantations could have an important effect on the fauna of the area. Not only are they concentrated islands of an introduced tree, but they are fenced, cultivated, and protected. This maintenance is important because, during the monsoon, plants grow and fruit and food seems abundant, but after the rains the land outside the plantation fences is soon dry and quickly over-grazed.

The two plantations presented contrasting vegetation. The plantation at Awsari, started in 1966, covers 87 hectares and is planted with Eucalyptus (*E. tereticornis*), Sissu (*Dalbergia sissu*), Siras (*Albizzia lebbek*), Neem (*Melia azadirachta*), and Tarwad (*Cassia auriculata*).

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[1] Accepted July 26, 1973.

The plantation consists of two distinct areas: one, called the "inner area" in this paper, is almost 100 per cent Eucalyptus trees, 10-14 metres high, with little understory; the other, called "the outer area", has approximately 50 per cent of the ground covered with trees of several species, 3-7 metres high, with the remainder of the ground covered by grass and underbrush fading into the surrounding barren grasslands. The Pachgaon plantation, 57 kilometres to the south, covers 238 hectares and is planted with Eucalyptus, Babul (*Acacia arabica*), Silver Oak (*Grevillea* sp.), and a species of bamboo. The trees are small (7-10 metres high) and very widely scattered. The extensive understory is composed of grass and shrubs up to one metre high.

The two plantations show stages of vegetation structure similar to ecological succession. These stages do not represent a natural succession because the tree species are introduced and maintained by man but they can be thought of as stages in a plantation development: from barren grassland, through protective fencing with high grass and scattered small trees, to thick plantations with outer areas of diverse vegetation.

The aim of this study was to categorize the avifauna of each plantation by species, abundance, position, and nesting activity. The study began in July during the height of the monsoon and continued for a total of five months into the December dry season.

METHODS AND MATERIALS

Awsari or Pachgaon plantation was observed during 34 days between 11 July 1970 and 4 December 1970. Birds were identified by plumage with 7 × 35 binoculars on systematically walked routes through the plantations. After September, two mist nets (12.8 × 2.1 m, 38 mm mesh) were available which were put up for a total of 400 net-hours in various locations within the study areas. Other observations at Awsari included perching and nest locations of selected common species of birds.

RESULTS AND DISCUSSION

Extensive changes in species composition were observed at the monsoon season. Table 1 shows that 20 of the 48 identified species were observed in either area for the entire length of the study. Nine species were observed for the first time at the end of the monsoon and stayed in the area until the end of the study. Three species left the area after the monsoon and 16 species were observed for only a short time.

As only five of these species (*Coturnix coturnix, Sylvia hortensis, S. curruca, Carpodacus erythrinus,* and *Emberiza bruniceps*) are described as being migratory (Ali 1968), the extensive seasonal changes in species could indicate the principal effect of these plantations on local avifauna. After the monsoon, as the grazed grasslands surrounding the plantations become dry, the vegetative structure within the plantations remains stable. Even though there is no additional fruiting associated with these changes, opportunistic local birds can invade

TABLE 1

IDENTIFIED SPECIES

	Species	Dates Observed						Approx. No.
		J.	A.	S.	O.	N.	D.*	
Residents	House Crow (*Corvus splendens*)	–	–	–	–	–	–	C
	Jungle Babbler (*Turdoides striatus*)	–	–	–	–	–	–	C
	Baybacked Shrike (*Lanius vittatus*)	–	–	–	–	–	–	C
	House Sparrow (*Passer domesticus*)	–	–	–	–	–	–	C
	House Swift (*Apus affinis*)	–	–	–	–	–	–	C
	White Scavenger Vulture (*Neophron percnopterus*)	–	–	–	–	–	–	C
	Jungle Crow (*Corvus macrorhynchos*)	–	+	–	+	–	+	C
	Redvented Bulbul (*Pycnonotus cafer*)	–	+	–	+	–	+	C
	Drongo (*Dicrurus adsimilis*)	–	+	–	+	–	+	11
	Indian Wren Warbler (*Prinia subflava*)	–	+	–	+	–	+	11
	Common Myna (*Acridotheres tristis*)	–	+	–	+	–	+	C
	Whitethroated Munia (*Lonchura malabarica*)	–	+	–	+	–	+	C
	Common Green Bee-eater (*Merops orientalis*)	–	+	–	+	–	+	C
	Pariah Kite (*Milvus migrans*)	–	+	–	+	–	+	C
	Little Brown Dove (*Streptopelia senegalensis*)	–	+	–	+	–	+	C
	Indian Robin (*Saxicoloides fulicata*)	+	+	+	+	+	+	C
	Rufousbacked Shrike (*Lanius schach*)	+	+	+	+	+	+	C
	Roseringed Parakeet (*Psittacula krameri*)	+	+	+	+	+	+	C
	Alpine Swift (*Apus melba*)	+	+	+	+	+	+	C
	Ring Dove (*Streptopelia decaocto*)	+	+	+	+	+	+	C
Emigrants	Crested Lark (*Galerida cristata*)	–	+					5
	Redwattled Lapwing (*Vanellus indicus*)	–	–	–				C
	Common Weaver Bird (*Ploceus philippinus*)	–	+	–	+			C
Immigrants	Purple Sunbird (*Nectarinia asiatica*)			–	–	–	–	5
	Blackwinged Kite (*Elanus caeruleus*)			–	–	–	–	2
	Small Skylark (*Alauda gulgula*)			–	–	–	–	C
	Common Quail (*Coturnix coturnix*)			–	+	–	+	C
	Crow Pheasant (*Centropus sinensis*)				+	+	+	4
	Common Babbler (*Turdoides caudatus*)				+	+	+	C
	Orphean Warbler (*Sylvia hortensis*)					–	+	5
	Common Rosefinch (*Carpodacus erythrinus*)					–	+	2
	Rufoustailed Finch-Lark (*Ammomanes phoenicurus*)					–	+	3

Transients	Common Nightjar (*Caprimulgus asiaticus*)	+						1
	Grey Shrike (*Lanius excubitor*)		−	+				2
	Small Minivet (*Pericrocotus cinnamomeus*)		−	−	−			2
	Lesser Whitethroat (*Sylvia curruca*)			+				1
	Rain Quail (*Coturnix coromandelica*)				−			1
	Pied Bushchat (*Saxicola caprata*)			−	−			2
	Yelloweyed Babbler (*Chrysomma sinense*)					+		C
	Purplerumped Sunbird (*Nectarinia zeylonica*)						+	1
	Indian Pipit (*Anthus novaeseelandiae*)					−	+	12
	Quaker Babbler (*Alcippe poioicephala*)						+	1
	Redwinged Bush Lark (*Mirafra erythroptera*)						+	1
	Wood Shrike (*Tephrodornis pondicerianus*)					−	+	3
	Redheaded Bunting (*Emberiza bruniceps*)					+	+	2
	Ashy Wren-Warbler (*Prinia socialis*)						+	3
	Whitebacked Munia (*Lonchura striata*)						+	1
	Spotted Munia (*Lonchura punctulata*)						+	1

Species observed at Pachgaon only ———, Awsari only +++, both —+—+, C means common. *J=July, A=August, etc.

the plantations and take advantage of the protection and food sources offered by the more stable vegetation.

During the dry months, the grasslands outside the plantations were observed to contain only a few Larks, Pipits, and Crows. Table 1 shows that 13 species were observed at Pachgaon and not Awsari, 18 at both, and 17 at only Awsari. The definite increase in vegetation seen in the stages of plantation development and these concomitant changes in resident species further suggest the parallel of plantation development to ecological succession.

The results of mist netting showed that the birds at Awsari were concentrated in the outer, more diverse, area. Over three times as many species and almost seven times as many birds per net-hour were captured in the outer area as in the inner area. Perhaps the higher foliage of the Eucalyptus tree caused fewer birds to be captured in the ground-level nets in the inner area, but walking observations supported the conclusion that few birds forage in the inner area. Data taken over nine days shows that as many birds were seen perching on Eucalyptus as other trees. However, tabulation of the nest locations of the Common Weaverbird (*Ploceus philippinus*), Redvented Bulbul (*Pycnonotus cafer*), Rufousbacked Shrike (*Lanius schach*), and Little Brown Dove (*Streptopelia senegalensis*) at Awsari showed that no nests were found in Eucalyptus trees or in the inner area but 74 nests were found in the outer area on Babul, Cassia, Sissu, and one Toddy Palm (*Borassus flabellifer*).

Orians (1969) has stated that the number of bird species in undisturbed forests in Costa Rica is not measurably affected by the number of species of trees in the forest. The difference in the bird species diversity between the inner and outer areas at Awsari seems to contradict this finding. Even though there is a wider vertical distribution of foliage in the primarily single species inner area, more birds and more species were observed in the outer area containing multiple species of trees. This difference could be associated with a "quality" of the Eucalyptus tree to support bird life rather than the height of foliage distribution or tree species diversity.

Thus, besides their economic importance and despite the controversial usefulness of Eucalyptus to wildlife, these introduced plantations have enhanced the local avifauna by providing stable vegetation. It is probable that the usefulness of these plantations to wildlife would be much increased if more diverse tree species were planted.

ACKNOWLEDGEMENTS

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A new species of *Eriocaulon* from Maharashtra[1]

BY

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(*With a plate*)

Eriocaulon tuberiferum sp. nov.

Herbae tuberiferae, tuberibus 5-15 stipitatis *c.* 4 mm longis 2.5 mm latis ovalibus vel bilobatis dense pilosis, pilis unicellularibus, caule reducto, foliis basalibus rosulatis linearilanceolatis recurvatis 1.6-4.3 cm longis, medio 2-3 mm latis, acutis utrinque glabris 5-7 nervatis, vaginis viridibus ad pedunculos arcte adpressis 2.5-4.5 cm longis glabris ad apicem oblique fissis, pedunculis 1 vel 2 (raro 3) gracilibus 11-18 cm longis 5- vel 6-costatis, in siccitate conspicue tortis glabris, capitulis globosis niveis 3-7 mm diametro, bracteis involucrantibus numerosis lanceolatis *c.* 1.7 mm longis 1.1 mm latis obtusis glabris nigris, receptaculo glabro, bracteis receptacularibus atroviridibus concavis 2-2.8 mm longis *c.* 1 mm latis obtusis versus apicem dorso villosis; floribus masculis in omnes partes capituli numerosis, calyce spathaceo atroviridi *c.* 2.3 mm longo 1.8 mm lato distincte 3-lobato sursum dorso dense piloso, petalis 3 pilosis in tubum membranaceum album *c.* 1.4 mm longum connatis, loborum petalorum uno distincte magniore et ultra bracteolos receptaculares exserto *c.* 2 mm longo 1 mm lato, lobis minoribus *c.* 1.1 mm longis *c.* 0.5 mm latis, lobis omnibus medio glanduliferis, staminibus 6, antheris juventute albis senectute nigrescentibus, pistillodiis 3 flavidis in tubo petalorum occultis; floribus foemineis paucis solum in peripheria capituli dispositis, sepalis 3 libris viridibus concavis rotundatis *c.* 1.9 mm longis *c.* 0.4 mm latis sursum dorso dense pilosis, petalis 3 subaequalibus papyraceis spathulatis 1.9-2.7 mm longis 0.25-0.5 mm latis dense pilosis, glandula subapicali, ovario parvo trigono *c.* 0.6 mm longo *c.* 0.25 mm lato triloculari, stigmatibus 3 *c.* 0.6 mm longis subsessilibus.

Tuberiferous herbs; tubers stalked, 5-15 per plant, about 4 mm long, 2.5 mm broad, oval or bilobed, covered with dense growth of

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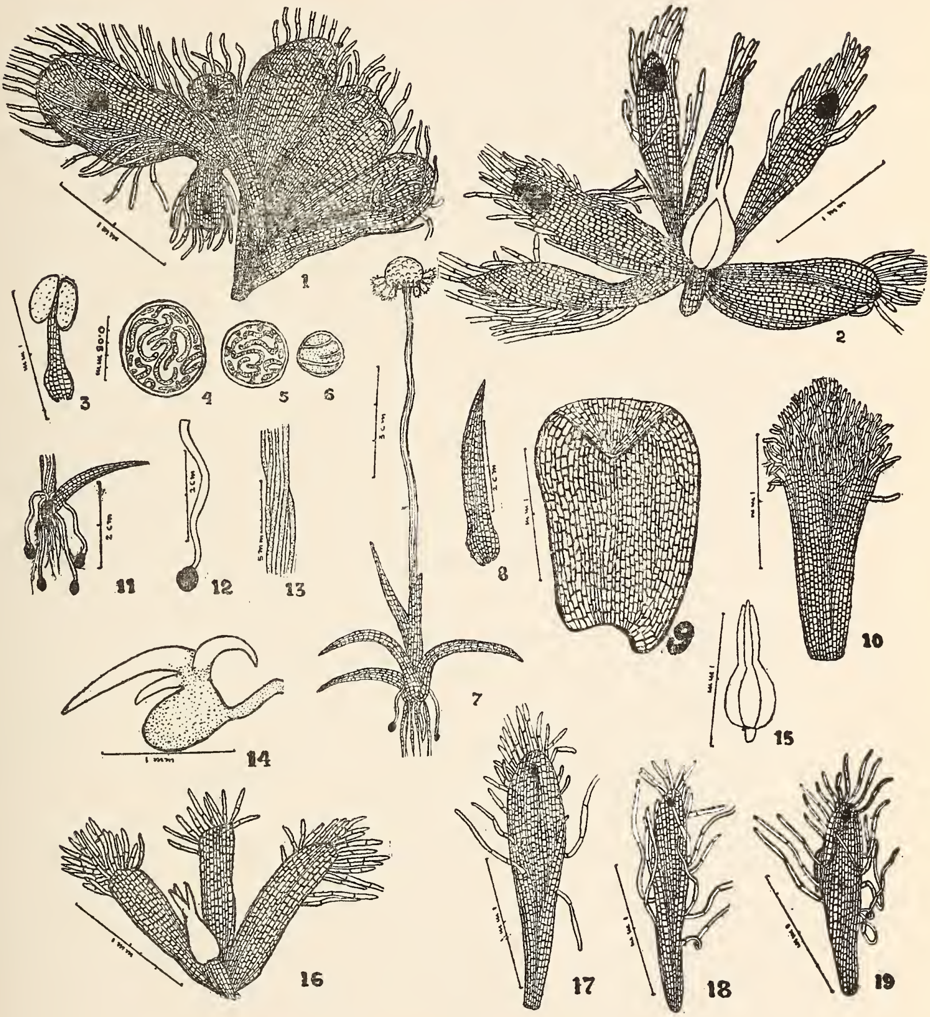
[1] Accepted July 27, 1972.

unicellular hairs. Stem reduced; leaves basal, rosulate, linearlanceolate, recurved, 1.6-4.3 cm long, 2-3 mm wide in the middle, acute at apex, glabrous on both the surfaces, 5-7 nerved; sheaths green, closely appressed to the peduncles, 2.5-4.5 cm long, glabrous, obliquely split at the apex; peduncles 1-2 (rarely 3) per plant, slender, 11-18 cm long, 5-6 costate, conspicuously twisted in the dried specimens, glabrous; heads globose, snow white, 3-7 mm in diameter; involucral bractlets many, lanceolate, about 1.7 mm long, 1.1 mm wide, obtuse at apex, glabrous, black; receptacle glabrous; receptacular bractlets deep green, concave, 2-2.8 mm long, about 1 mm wide, obtuse at apex, densely white villous on the back towards the apex: Staminate florets numerous, both towards periphery and the centre of the head; calyx spathaceous, deep green, about 2.3 mm long, 1.8 mm wide, distinctly 3-lobed, densely hairy on the back towards the apex; petals 3, hairy, united into a whitish membraneous tube about 1.4 mm long, one of the petal lobes distinctly larger and protruding beyond the receptacular bractlets; the larger lobe about 2 mm long, 1 mm wide, the smaller ones about 1.1 mm long, about 0.5 mm wide; all the lobes medially gland-tipped; stamens 6, anthers white when young but become blackish at maturity; pollen grains spheroidal varying from 26.6 to 53.2 μ in diameter, spiraperturate or with many distinct convoluted unthickened bands, exine smooth; pistillodes 3, pale yellow, hidden in petal tube: Female florets few, restricted to the periphery of the head; sepals 3, free, green, concave, rounded at apex, about 1.9 mm long, about 0.4 mm broad, densely hairy on the back towards the apex; petals 3, subequal, papery, spathulate, 1.9-2.7 mm long, 0.25-0.5 mm wide, densely hairy, gland subapical; ovary small, trigonous, about 0.6 mm long, about 0.25 mm wide, trilocular, 3-ovuled; stigmas 3, about 0.6 mm long, subsessile.

Holotype was collected from Panhala (938 m alt.), Kolhapur district, Maharashtra, along the margins of puddles on 28th July 1968 and is deposited in National Herbarium, Calcutta under Kulkarni and Desai 537 and the Isotypes 538-540 are deposited in the Herbarium of the Shivaji University, Botany Department, Kolhapur.

E. tuberiferum is closely related to *E. ritchieanum* Ruhl. and *E. leucomelas* Steud. From the former it differs in the transition of the anther colour from white in younger condition to blackish at maturity and in its distinct anisopetalous male flower, the largest petal of which projects beyond the receptacular bractlets giving fringed appearance to the head. From the latter species it differs in the petal characters of the male flowers and in having distinctly oblique mouth for the penduncular sheaths. It differs from all the species of *Eriocaulon* known so far in its tuberiferous habit.

Members of this species are commonly seen along the margins of puddles at Panhala from July-September. They grow in association


1
1 mm
2
1 mm
3
1 mm
0.08 mm
4
5
6
3 cm
7
8
1 cm
9
1 mm
10
1 mm
11
2 cm
12
1 cm
13
5 mm
14
1 mm
15
1 mm
16
1 mm
17
1 mm
18
1 mm
19
1 mm

Eriocaulon tuberiferum Kulkarni et Desai

Fig. 1. Male flower. Fig. 2. Female flower. Fig. 3. Stamen. Figs. 4-6. Pollen grains. Fig. 7. Entire plant. Fig. 8. Leaf. Fig. 9. Involucral bractlet. Fig. 10. Receptacular bractlet. Fig. 11. Basal part of the plant showing tubers. Fig. 12. Stalked tuber. Fig. 13. A part of peduncle showing twists. Fig. 14. Germinated tuber. Fig. 15. Gynoecium. Fig. 16. Gynoecium with sepals. Figs. 17-19. Petals of the female flower.

with *Isoetes*. The species has also been collected from Radhanagari (Kolhapur district) where it grows in similar habitat. Further intensive collections may reveal its presence in other areas of Sahyadri ranges enjoying similar ecological conditions.

Inspite of very close observations during the last three years, we have failed to collect fruiting specimens of this species from both the localities. It appears probable that the species mainly reproduces by tubers in nature.

The Royal Botanic Gardens, Kew, when referred to, informed us that the specimens resembled *E. leucomelas* Steud. (*E. melaleucum* Mart.) superficially, appearing to be distinct both in foliage and flower and belonged to *Eriocaulon ritchieanum* Ruhl. but with abnormal flowers possibly due to nematode attack. The structures referred here as tubers were suspected by the authorities of Kew to be nematode cysts. However, later studies by us on the ontogeny and the germinability of the tubers (Kulkarni & Desai 1970), precluded the possibility of these being nematode cysts. Further, detailed examination of the specimens of *Eriocaulon ritchieanum* represented in national and regional herbaria of the Botanical Survey of India revealed that the tuberiferous specimens differed in some of their vegetative as well as floral characters apart from their tuberiferous habit from *E. ritchieanum*. Compartive account of the differentiating features of *E. ritchieanum, E. leucomelas* and *E. tuberiferum* is given in Table I.

TABLE I

	E. leucomelas	*E. ritchieanum*	*E. tuberiferum*
Peduncular Sheath	mouth truncate, narrowly scarious	mouth oblique or divided in 2-5 segments	mouth distinctly oblique not scarious
Peduncles	1-4, 5-8-ribbed	1-many, not ribbed	1-3, 5-6 ribbed, twisted
MALE FLOWER			
Calyx	spathaceous, split on one side	spathaceous, split on one side, truncate or obscurely 3-lobed	spathaceous, split on one side, distinctly 3-lobed
Corolla	2 lobes subequal	lobes subequal	lobes unequal, the largest protruding beyond the receptacular bractlet giving fringed appearance to the head

Anthers	yellow turning black	white or yellow	white turning black
FEMALE FLOWER			
Sepals	elliptic to obovate boat shaped, acute	oblong or obovate boat shaped, truncate or rounded, denticulate	oblong, concave, rounded at apex
Petals	equal, linear spathulate	equal, linear spathulate	subequal, oblanceolate spathulate
Seeds	elliptic, black	subglobose, brown, angular	——

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[2] Though many workers (Fyson 1921, 1922; Moldenke 1969 a and b) have described petals of the male flowers in *E. leucomelas* to be subequal, Fischer (1935) describes them to be distinctly unequal with the largest petal protruding beyond the receptacular bractlets.

Considering all these features it has now been proposed to assign the tuberiferous specimens to a distinct species, *Eriocaulon tuberiferum*. The specific epithet has been chosen from their remarkable tuberiferous habit, a feature unique to the genus *Eriocaulon*.

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Fishery resources of Ullal (Mangalore) in relation to certain environmental factors during 1963-67[1]

BY
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(*With four text-figures*)

INTRODUCTION

Ullal, an important fishing centre situated 3 Km south of Mangalore, was known for shark fishery in the past. However, owing to the decline in the shark fishery, fishing for sardine, mackerel etc has been resorted to bottom dwelling during the past two decades. While Mangalore is at present a landing centre for ground fishes of the mechanised boats, Ullal is of special significance, being the nearest fishing village where various types of indigenous gears are employed mainly for pelagic fishes. Yet, the fishery potentiality of this area has remained unknown. However, certain observations on the mackerel fishery of this area have been made by Rao *et al.* (1962). This account relates to the total fish landings and the major categories of fishes contributing to the fishery with observations on the relation of sardine and mackerel catches to plankton, salinity, temperature and rainfall.

FISHING METHODS

The types of gears operated at Ullal are shown in Table I.

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TABLE I

DETAILS OF FISHING GEARS

Name of the Unit	Man power	Type of net	Dimensions of the net*	Whether selective or non-selective	Area of operation**
Beesubale/1 dugout	2 to 7	Cast net	$\frac{5.4}{1.5}$	Non-selective	$\frac{\text{1 to 6}}{\text{2 to 18}}$
Kanthabale/1 dugout	3 to 4	Bottom set gill net	16 to 25 pieces, each $\frac{4 \times 3}{5}$	Selective	$\frac{\text{5 to 12}}{\text{10 to 13}}$
Chalabale/1 dugout	3 to 9	Gill net	$\frac{\text{7 to 10 pieces, each 12 to 30 x 4 to 6}}{\text{1 to 1.5}}$	Selective	$\frac{\text{2 to 5}}{\text{2 to 10}}$
Manangubale/1 dugout	3 to 9	Gill net	$\frac{\text{7 to 10 pieces, each 12 to 30 x 4 to 6}}{\text{1 to 1.5}}$	Selective	$\frac{\text{2 to 5}}{\text{2 to 10}}$
Pattabale/3 dugout canoes	24	Gill net	$\frac{\text{7 to 8 pieces, each 16 to 20 x 10 to 12}}{\text{2 to 2.5}}$	Selective	$\frac{\text{2 to 8}}{\text{4 to 20}}$

TABLE I (*Continued*)

Name of the Unit	Man power	Type of net	Dimensions of the net*	Whether selective or non-selective	Area of operation**
Bolingerbale/1 dugout	3	Gill net	$\frac{\text{7 to 10 pieces, each 12 to 30 x 4 to 6}}{\text{1 to 1.25}}$	Selective	$\frac{\text{2 to 5}}{\text{4 to 10}}$
Idabale/3 dugout	20 to 24	Gill net	$\frac{\text{7 to 9 pieces, each 12 to 30 x 4 to 6}}{\text{1.5 to 2.0}}$	Selective	$\frac{\text{2 to 5}}{\text{4 to 12}}$
Odubale/1 dugout	5	Gill net	15 to 20 pieces, each $\frac{\text{20 x 6}}{\text{7 to 10}}$	Selective	$\frac{\text{10 to 20}}{\text{15 to 35}}$
Kollibale/2 dugout	12 to 14	Boat seine	$\frac{\text{20 x 6}}{\text{1.5}}$	Non-selective	$\frac{\text{3 to 6}}{\text{8 to 15}}$
Maribale/3 dugout	24	Boat seine	$\frac{\text{36 x 22}}{\text{3 to 6.5}}$	Selective	$\frac{\text{8 to 25}}{\text{12 to 40}}$
Rampani/1 outrigger and 4 dugout	50 to 60	Shore seine	$\frac{\text{300 to 400 pieces, each 2 to 6 x 5 to 10}}{\text{1.5 to 4.5}}$	Non-selective	$\frac{\text{1.5}}{\text{5 to 8}}$

* Dimensions: $\frac{\text{Length} \times \text{breadth in metres}}{\text{Mesh in cm}}$

** $\frac{\text{distance from shore in Km}}{\text{depth in metres}}$

While most of the nets are operated by the fishermen of Ullal, fishing by *Rampani* and *Kollibale* at this centre is done by fishermen from the neighbouring villages north and south of Ullal respectively. Normally, fishing is suspended from the middle of June to end of July due to the unfavourable conditions during the south-west monsoon. Fishing is resumed with cast net (*Beesubale*) operations mainly for prawns, soles and sardines during August-October following which this gear together with *Chalabale* and *Idabale* are employed for catching sardines exclusively. Occasionally, a small meshed (about 1 cm) cast net called *Kooribale* is also operated during the monsoon for catching small varieties of fishes. Although big meshed gill nets namely *Pattabale* and *Kanthabale* are operated for catching medium and big-sized mackerel, other fishes like *Hilsa kanagurta, Anadontostoma chachunda,* sharks and rays and prawns consisting of mostly *Penaeus* sp. are also caught. The other types of gill nets namely *Manangubale* and *Bolingerbale* are operated exclusively for *Thrissocles* spp. and *Kowala coval* respectively. *Odubale* usually operated from September to February, catch mainly *Cybium* spp., *Chirocentrus* spp., and sharks and rays. *Kollibale* and *Rampani* are employed when large shoals of pelagic fishes like sardine and mackerel occur. During the summer months of March to May *Maribale* operations are carried out for catching cat fishes.

COLLECTION OF DATA AND ESTIMATION OF LANDINGS

The data presented here relate to the period July 1963 to June 1967 when observations were made on all the working days. Usually about 20 per cent of the total number of each type of unit operated were examined and the monthly total catch in respect of each type of unit was estimated as was followed by Rao *et al.* (1962). While estimating the catch, the weights of major categories of fishes such as sardine, mackerel, prawns etc. were noted down separately. Surface plankton and water samples for salinity estimation were collected off Ullal once a week together with temperature readings. An attempt was made to correlate these data with the fluctuations in the pelagic fishery resources of this area.

ANALYSIS OF DATA

The data collected have been analysed to study the seasonal variations in the catch during the different years, fluctuations in the annual catch and the dominant species contributing to the fishery. In order to determine the relative importance of the different gears and the commercially important species caught by them, the data have been subjected to an analysis on a gearwise basis. Since the fishery for oil sardine and mackerel is known to fluctuate from year to year, data on plankton volume, temperature, salinity and rainfall of this area have been plotted against the landings of these species during the period of this investigation to find out the relationship, if any.

a) *Annual and seasonal variations in the total catch*

Comparing the total fish landings of the different years (Table II) it is seen that catches during 1964-65 and 1966-67 (718.4 and 747.2 tonnes respectively) were better than those of 1963-64 and 1965-66 (228.8 and 454.9 tonnes respectively). From the monthly variations in the catch for different years, it has been observed that the fishery was generally good between September and April with the peaks occurring during September-October and January-April, the latter being dominant during most of the years. Usually, the catches dwindled after April and the poor landings recorded during June-July may be attributed to the decreased fishing activity during the peak of the south-west monsoon.

b) *Catch composition and gearwise landings*

Although the category of fishes such as *Arius* spp. *Kowala coval, Cynoglossus* spp., *Leiognathus* spp. and *Thrissocles* spp. together classified as 'others' constituted the bulk of the landings during 1963-64 and 1964-65 (Table II), oil sardine remained the single largest fishery in all the years. It is interesting to note that the oil sardine landings even exceeded those of 'others' during 1965-66 and 1966-67 constituting 62.4 and 51.6 per cent respectively. The trend of the monthly oil sardine catches generally coincided with that of the total catch.

The mackerel fishery was good only during 1963-64 when it formed 29.3 per cent which was even higher than the oil sardine catch (22.8%). Subsequently, the fishery declined with a tendency for revival during 1966-67. Unlike the sardine fishery, the mackerel fishery was restricted to short periods with the peak occurring during October and November. However, a secondary peak was noticed in May during all the years except in 1966-67. Comparing the trend of oil sardine and mackerel fishery, no definite relation was discernible on a monthwise basis. However, from the annual trend it was observed that while the oil sardine catches were on the increase leading to a bumper fishery in 1966-67, the mackerel fishery was declining touching its lowest ebb in 1965-66.

As in the case of mackerel, the prawn fishery also was active only for brief periods during July-September which coincided with the south-west monsoon season. The fishery was supported chiefly by a single species namely, *Metapenaeus dobsoni*. The prawn fishery noticed during January, February and sometimes April was meagre and it was

TABLE II

MONTHWISE CATCH IN KG OF DIFFERENT CATEGORIES OF FISHES DURING DIFFERENT YEARS

		July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	Total	%age
1963-64	Oil sardine	—	—	382	4729	1241	—	1330	26729	17694	—	—	—	52105	22.8
	Mackerel	—	—	10718	25785	4032	—	278	798	3898	9191	12234	95	67029	29.3
	Prawns	164	1582	315	—	—	—	762	445	—	200	35	76	3579	1.5
	Others	461	2091	15480	15341	2383	8050	20706	14376	3450	10264	6501	7017	106120	46.4
	Total	625	3673	26895	45855	7656	8050	23076	42348	25042	19655	18770	7188	228833	
1964-65	Oil sardine	123	7531	6028	60330	20394	5312	13024	13879	9330	17821	18171	206	172149	24.0
	Mackerel	—	—	—	2832	8852	5410	4066	—	4815	946	2420	1123	30464	4.2
	Prawns	6393	5190	196	—	—	—	—	—	26	157	80	13	12055	1.7
	Others	16627	7730	54622	7554	4049	2701	7676	119612	251543	7237	17691	626	503768	70.1
	Total	23143	20451	60846	70716	33295	13423	24766	133491	265714	26161	38362	1968	718436	
1965-66	Oil sardine	2040	15265	16204	6848	54702	28380	73759	29430	26755	28475	1875	—	283733	62.4
	Mackerel	—	28	1523	5913	1314	3	778	28	—	—	382	6	9975	2.2
	Prawns	—	2163	4713	502	21	22	185	105	312	839	194	64	9120	2.0
	Others	—	12288	66790	19496	17047	6919	4706	6234	8643	4885	3495	405	152078	33.4
	Total	2040	29744	89230	32750	73084	35324	79428	35797	35710	34199	5946	475	454906	
1966-67	Oil sardine	—	56572	66474	13994	23645	36453	10500	60747	35482	60005	19166	2580	385618	51.6
	Mackerel	—	—	3889	16908	2244	54	285	—	—	—	—	—	23380	3.1
	Prawns	—	2753	8726	225	219	7	33	—	—	—	—	—	11963	1.6
	Others	—	4411	11952	17585	5251	4678	5341	1438	2288	224012	48997	329	326282	43.7
	Total	—	63736	91041	48712	31359	41192	16159	62185	37770	284017	68163	2909	747243	

constituted by bigger varieties such as *Penaeus indicus* and *P. merguiensis.*

Among the 'other' categories, *Arius* spp. accounted for the bulk of this group during 1964-65 and 1966-67 forming 73 and 82 per cent respectively, whereas *Kowala coval, Cynoglossus* spp., *Leiognathus* spp. and *A. chacunda* together formed about 72 per cent during 1963-64 and *Cynoglossus* spp., *Leiognathus* spp., *A. chacunda* and *H. kanagurta* 73 per cent during 1965-66. It was interesting to note that the cat fish fishery was prevalent only during alternate years. Though this fishery was restricted to one or two months in a year (February-March 1965 and April 1967), huge quantities were landed within this short period. When the cat fish shoals are sighted, the fishermen generally fish them exclusively because of the better returns. The fishery for *Kowala coval,* generally lasting from December to May, constituted about 38.0, 3.1, 13.0 and 3.0 per cent respectively during the years 1963-64 to 1966-67. *Cynoglossus* spp. and *Leiognathus* spp., appeared together in large quantities from August to October, forming about 19.0, 13.3, 51.3 and 1.5 per cent respectively during the above years. *Thrissocles* spp. were caught throughout the year but the maximum quantity was landed generally between July and October. They constituted 10.4, 3.4, 11.8 and 2.1 per cent respectively among the 'other' categories during the years of study.

For a study of the importance of the various types of gears, the catches landed by these during the different years are given in Table III from which it can be seen that *Maribale, Chalabale,* Cast nets, *Bolingerbale, Pattabale* and *Kanthabale* were the most important gears accounting for the major portion of the catch during the entire period. Among these, *Maribale* landed the maximum catches during 1964-65 and 1966-67 and *Chalabale* during 1965-66. The landings by cast nets were consistently good throughout the period. Except during 1966-67, *Bolingerbale* brought fairly good catch. The landings by *Pattabale* were best in 1963-64 and those of *Kanthabale* in 1966-67.

The proportion of each of the major category of fishes caught by the different gears (Table IV), shows that sardines are netted mainly by *Chalabale* and cast nets. *Kollibale,* the most commonly used gear in the southern region for sardine fishery, was operated only on a few occasions during 1964-65 and 1966-67, which accounted for a small percentage of the sardine catch. Similarly, *Rampani,* a shoreseine operated for sardine and mackerel in the northern region, was employed only once in 1966-67 accounting for 6.2 per cent. For the other pelagic variety namely mackerel, *Pattabale* was found to be the most successful gear accounting for more than two-thirds of the entire mackerel catch during all the years. The rest of the catch was by *Kanthabale.* Majority of the prawn catch was by cast nets during all the years.

TABLE III

GEARWISE CATCH IN KG OF THE MAJOR CATEGORIES OF FISHES DURING DIFFERENT YEARS

		Cast net	Kantha bale	Chala bale	Manangu bale	Patta bale	Kolli bale	Bollinger bale	Mari bale	Ida bale	Odu bale	Rampani	Total
1963-64	Oil sardine	9875	—	42230	—	—	—	—	—	—	—	—	52105
	Mackerel	—	2014	30	—	64985	—	—	—	—	—	—	67029
	Prawns	2061	1434	—	—	84	—	—	—	—	—	—	3579
	Others	22759	14483	15366	470	12960	220	39862	—	—	—	—	106120
	Total	34695	17931	57626	470	78029	220	39862	—	—	—	—	228833
1964-65	Oil sardine	83677	—	84752	—	—	3720	—	—	—	—	—	172149
	Mackerel	—	6217	—	—	24247	—	—	—	—	—	—	30464
	Prawns	11288	246	375	146	—	—	—	—	—	—	—	12055
	Others	67310	11048	22411	10093	2720	156	16320	367610	—	6100	—	503768
	Total	162275	17511	107538	10239	26967	3876	16320	367610	—	6100	—	718436
1965-66	Oil sardine	23955	414	258463	—	—	—	—	—	901	—	—	283733
	Mackerel	14	3228	—	10	6719	4	—	—	—	—	—	9975
	Prawns	5296	2029	1329	466	—	—	—	—	—	—	—	9120
	Others	78765	15949	24357	3830	6070	1301	20636	—	—	1170	—	152078
	Total	108030	21620	284149	4306	12789	1305	20636	—	901	1170	—	454906
1966-67	Oil sardine	145322	735	210955	14	—	4592	—	—	—	—	24000	385618
	Mackerel	—	7318	4	—	16058	—	—	—	—	—	—	23380
	Prawns	11150	728	42	43	—	—	—	—	—	—	—	11963
	Others	5570	27642	4427	3246	3581	165	9632	267003	—	5016	—	326282
	Total	162042	36423	215428	3303	19639	4757	9632	267003	—	5016	24000	747243

TABLE IV

PERCENTAGES OF MAJOR CATEGORIES OF FISHES CAUGHT BY DIFFERENT GEARS

		Cast net	Kanthabale	Chalabale	Manangubale	Pattabale	Kollibale	Idabale	Rampani
1963-64	Oil sardine	19.0	—	81.0	—	—	—	—	—
	Mackerel	—	3.0	—	—	97.0	—	—	—
	Prawns	57.6	40.1	—	—	2.3	—	—	—
1964-65	Oil sardine	48.6	—	49.2	—	—	2.2	—	—
	Mackerel	—	20.4	—	—	79.6	—	—	—
	Prawns	93.6	2.0	3.1	1.3	—	—	—	—
1965-66	Oil sardine	8.4	0.2	91.1	—	—	—	0.3	—
	Mackerel	0.1	32.4	—	0.1	67.4	—	—	—
	Prawns	58.1	22.2	14.6	5.1	—	—	—	—
1966-67	Oil sardine	37.7	0.2	54.7	—	—	1.2	—	6.2
	Mackerel	—	31.3	—	—	68.7	—	—	—
	Prawns	93.2	6.2	0.3	0.3	—	—	—	—

However, fairly good proportion of the prawn catches was landed by *Kanthabale* during 1963-64 and 1965-66.

Relation of the Pelagic Fisheries to Ecological conditions

Mean monthly temperature, salinity and displacement volume of plankton of the surface waters off Ullal together with the sardine and mackerel landings are shown in Text Figs. 1 to 4. Temperature was low during August-January, the minimum value ranging between 25.4 to 25.6°C. However, within this period it showed an increase in October except in 1963-64 when it was in November. Temperature remained high during April-May (29.8 to 31.0°C). Salinity was low during August-September (13.9 to 30.9‰) followed by an increase till Decem-

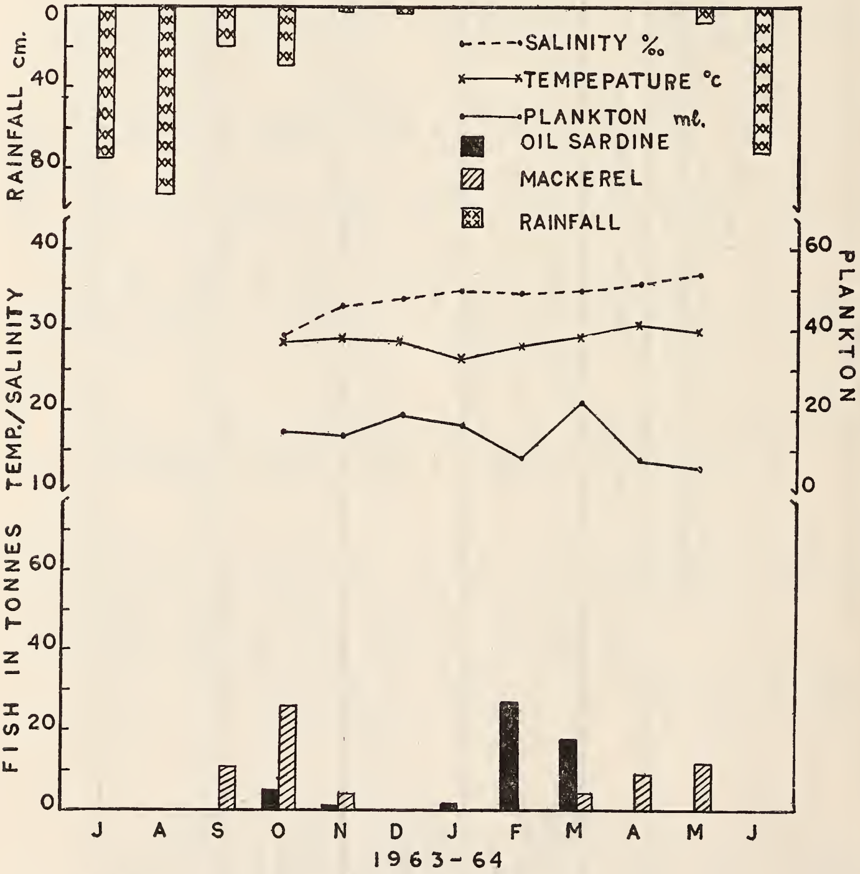

Fig. 1. Monthly landings of oil sardine and mackerel in relation to temperature, salinity, rainfall and plankton volume during 1963-64.

ber (29.4 to 35.1 ‰) with a drop in January-February (Figs. 2 to 4) except in 1963-64 when the salinity values were steadily rising (Fig. 1). Maximum values for salinity were obtained during April-May (34.2 to 37.0‰). The period of low salinity coincided with the south-west monsoon season (June to September) when the monthly maximum rainfall ranged from 86.8 to 95.0 cm. Comparing the annual rainfall during the four years of study, it was found to be highest in 1963-64 (306.5 cm) and lowest in 1965-66 (274.1 cm).

The characteristics of the plankton volume varied widely from year to year with peaks in December '63 (18.9 ml), March '64 (22.0 ml), October '64 (39.0 ml), May '65 (13.7 ml), October-November '65 23.3-24.5 ml) and February (13.0 ml) and May '66 (17.7 ml) and March '67 (37.8 ml). The minimum plankton volume was recorded during November '66 (1.8 ml) and the maximum in October '64 (39.0 ml). Considering the monthly variations of the plankton volume during

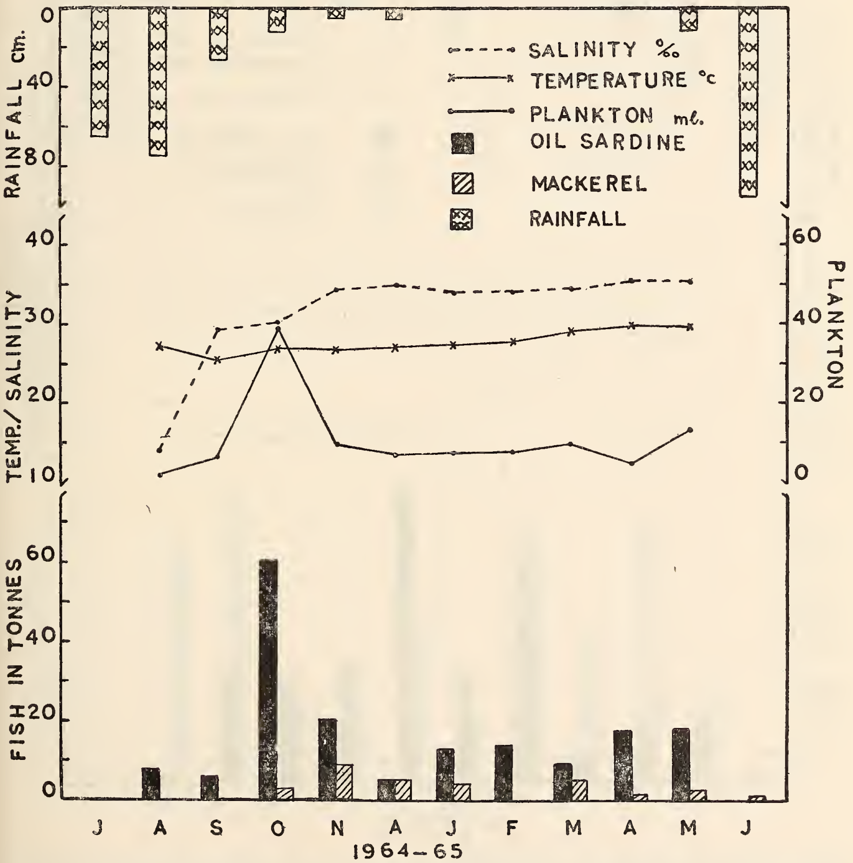

Fig. 2. Monthly landings of oil sardine and mackerel in relation to temperature, salinity, rainfall and plankton volume during 1964-65.

the different years, no definite relationship was discernible between these and the sardine and mackerel fisheries.

When the sardine fishery was good the temperature was found to range from 25.4 to 27.7°C and salinity from 30.1 to 33.8‰. However, in the course of this study, good catches of oil sardine were recorded even in higher ranges of temperature (28.0 to 30.5°C) and salinity (33.8 to 35.5‰) during the period February-April '67. At Calicut, while a temperature range of 28.0 to 29.0°C was found to be favourable for the sardine fishery, no consistent relation was noticed between salinity and the fishery (Sekharan 1962a). Along North Kanara coast the period of sardine fishery had temperature and salinity ranges of 26.8 to 30.3°C and 22.2 to 34.53‰ respectively (Ramamurthy 1965).

In general, the mackerel fishery was not as good as that of oil sardine, its peaks coinciding with the temperature and salinity ranges

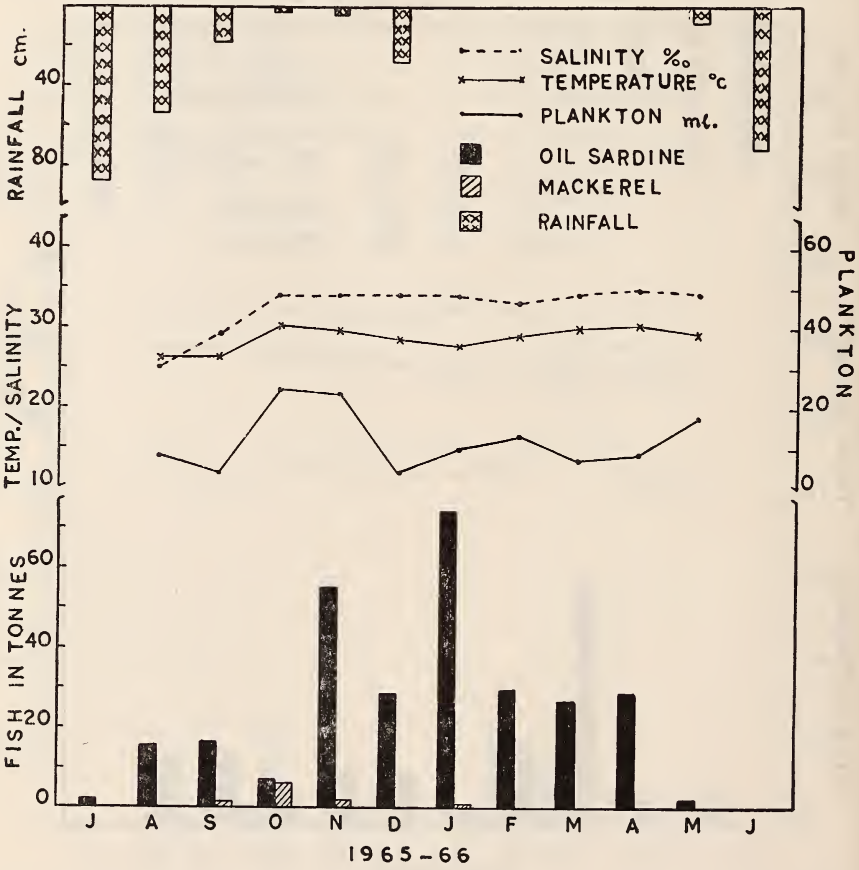

Fig. 3. Monthly landings of oil sardine and mackerel in relation to temperature, salinity, rainfall and plankton volume during 1965-66.

of 26.9 to 30.5°C and 29.4 to 34.4‰ respectively. In 1963-64, however, the fishery was good even at a higher salinity of 37.0‰ in May. Sekharan (1962b) stated that intermediate values for temperature (27.0 to 28.0°C) and salinity (34.2 to 35.44‰) representing an upward trend after their minimum values occurred during the mackerel season at Mandapam. Subsequently, while dealing with the mackerel fishery of Calicut, Pradhan & Reddy (1962) have reported that high temperature and salinity affect the fishery adversely. The mackerel season in North Kanara coast coincided with the transition period from the low salinity and temperature conditions during the south west monsoon period to the high salinity and warmer conditions in summer (Ramamurthy 1965).

Normally, the bulk of the sardine catch was landed following the period of heavy rainfall during the south-west monsoon season. How-

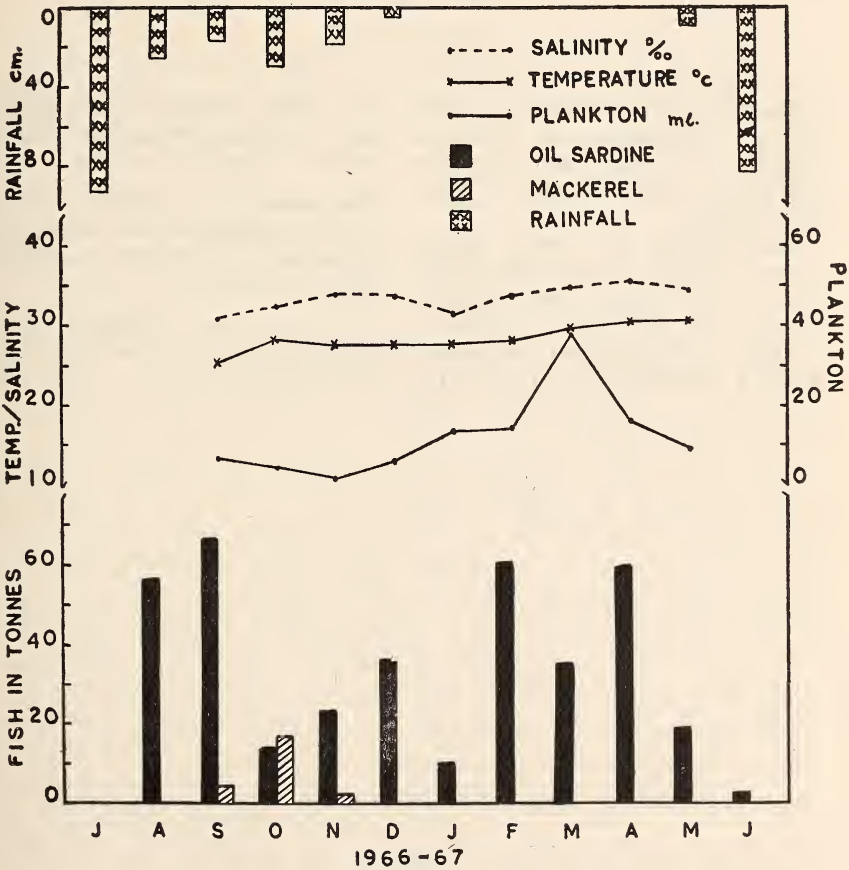

Fig. 4. Monthly landings of oil sardine and mackerel in relation to temperature, salinity, rainfall and plankton volume during 1966-67.

ever, fairly good quantities of oil sardine were also caught late in the season viz., February '64 and February and April '67 when the rainfall was negligible during the preceding months. The best catches of mackerel were also made following the south-west monsoon rains. The total mackerel landings appeared to have a direct relation to the annual rainfall, the maximum catch (67.0 tonnes) and rainfall (306.5 cm) occurring in 1963-64 and the minimum (9.97 tonnes and 274.1 cm respectively) in 1965-66. Pradhan & Reddy (1962), on the contrary, found an inverse relation between the annual rainfall and mackerel at Calicut. The sardine fishery at Ullal, on the other hand, was at its lowest (52.1 tonnes) in 1963-64 when the rainfall was heaviest (306.5 cm). The catches were better during 1965-66 and 1966-67 (283.7 and 385.6 tonnes respectively) when the annual rainfall was comparatively low (274.1 and 283.6 cm respectively).

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Observations on the breeding mechanism of *Biophytum candolleanum* Wt.

BY

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(*With a plate*)

Among angiosperms there are 28 families with heterostylous genera (Beryl S. Vuilleumier 1965). Of these, 5 families include trimorphic heterostyled genera. Plants reported to be trimorphic are: *Oxalis* (Mulcahy 1964; Ornduff 1964); *Averrhoa* (Ornduff, Pers. comm.); *Lythrum* (Darwin 1877; East 1940); *Nasaea* (Darwin 1877; East 1940); *Houstonia* (Darwin 1877); *Eichhornia* (Johnson 1924; Uchida 1953); *Pontedaria* (Hazen 1918; Ornduff 1966); *Reussia* (East 1940); *Anielema* (Vogel 1955) and *Biophytum* (Mayura Devi 1964).

In trimorphic hererostyly, a species will have 3 floral forms regarding length of style and height of anthers. This morphological heteromorphism is accompanied by biological specialisation in breeding. Considerable work has been done on the breeding mechanism of dimorphic heterostylous plants since Hildebrand (1866) and Darwin (1877) but relatively less is known about breeding of tristylous plants. Nora Barlow, grand daughter of Darwin, was the first to study the genetic mechanism of heterostylous plants viz. *Lythrum salicaria* and species of *Oxalis*. Since then Hazen (1918), Johnson (1924), East (1940), Lewis (1943), Uchida (1953), Vogel (1955), Bahadur (1963) and Ornduff (1964) have investigated this phenomenon.

Mayura Devi reported in 1964, that in the tristylous *Biophytum sensitivum* DC. floral trimorphism is associated with an incompatibility system. I studied the breeding mechanism of another species of the same genus viz. *B. candolleanum*, described by J. S. Gamble in his Flora of Madras Presidency, vol. i, 94.

Biophytum candolleanum (*B. sensitivium* var. *candolleana* Edgw. & Hook. f.) is a small unbranched annual with pinnately compound, sensitive leaves crowded at the apex of a narrow stem up to 35 cm in height. Peduncles many, axillary, up to 20 cm long but shorter usually. Flowers pedicellate, hermaphrodite, actinomorphic, hypogynous and trimorphic. The 3 forms of flowers are:

long-styled with mid and short stamens,
mid-styled with long and short stamens and
short-styled with long and mid stamens.

Fruits 5-valved loculicidal capsules protected by persisting sepals. Seeds 20-25 per fruit, very small, brownish red, tubercled and arillate. Growing season of the plant is from July to November.

TABLE 1

APPROXIMATE MEASUREMENTS IN MM OF FLORAL PARTS OF *B. candolleanum*

Floral part	Long-styled	Mid-styled	Short-styled
Pedicel (length)	5-10	5-10	5-10
Corolla (diameter)	15	15	15
Sepal (length)	3-3.5	3-3.5	3-3.5
Petal (width)	5-7	5-7	5-7
Corolla (length)	9-11	9-11	9-11
Long stamen	—	4	4
Mid stamen	2.5	—	2
Short stamen	1	1	—
Pistil (height)	3-3.5	2	1

Pollen grains are similar to those of *B. sensitivum* DC., in shape. There is gradation in size of pollen from short stamen to that of long. They form almost a regular series gradually increasing in size.

MATERIALS AND METHODS

Young plants of *B. candolleanum* collected from wild populations at Dharmadam, Tellicherry, Kerala, in July 1969 were used for the study initially. In 1970, plants collected from Palghat, Kerala, were used to repeat some of the crosses done previously. Plants were transplanted in the laboratory, in small wooden boxes. After flowering they were sorted out into long, mid and short-styled forms. Out of 135 plants, 30 were long-styled, 55 mid-styled and 50 short-styled.

Pollination experiments were conducted to find out incompatibility system, if any, in this species. To prevent visit of insects and contamination of pollen, inflorescences were kept enclosed in bags of polythene. In short-styled flowers, sepals had to be cut short to do artificial pollination. Flowers emasculated in the evening were often found withering by next morning. So when emasculation was necessary, it was done at midnight, before dehiscence of anthers. Pollinated flowers were again kept bagged.

POPULATION STRUCTURE

Eliot (1892) recorded a population composition of 25 long: 54 mid: 21 short or about 1:2:1 ratio in the tristylous *Oxalis suksdorfii*. In 1959, Faberge also reported a similar representation of forms in a population of the same species, which was composed of 246 long: 453 mid: 207 short. Ornduff, in 1964 examined ten sample populations. The mid-styled form made up the largest class in four of these.

As the random collection made for transplantation showed difference in proportion of the 3 forms in *B. candolleanum,* 3 more populations were counted to find out the frequency of the 3 types. Result is shown in table 2.

TABLE 2

POPULATION COMPOSITION OF *B. candolleanum*

Date	Place	Total number	Long		Mid		Short
20-8-'70	Palghat	90	20		37		33
12-9-'70	Dharmadam	176	20		80		76
25-9-'70	Dharmadam	200	31		106		63
	Total	466	71	:	223	:	172

It is evident that populations of *B. candolleanum* show what Finney (1952) called anisoplethy (inequality of different floral forms). In all observed cases the mid-styled form makes up the largest class and long-styled the smallest. Short-styled form comes close to the mid-styled, in number. But there is no definite 1:2:1 ratio.

POLLINATION

To find out whether self pollination was taking place, flowers of the 3 forms were kept bagged and unpollinated, for several days. Though flowers opened regularly, there was no fruit-setting even in one. This shows that insect visit is essential for pollination and setting of fruits. Insects like honey-bees, bugs and flies were found visiting the flowers in field.

Self fertility of the 3 forms of flowers was determined by artificial pollination. Flowers opened inside polythene bags were used for this. In the first instance, pollen from the longer set of stamens was transferred to the stigmas of the same flower. Later the same experiments were repeated with pollen from the short stamens. Results are shown below.

A SELFING WITH POLLEN FROM LONGER STAMENS OF SAME FLOWER

Type of flower	Number of flower pollinated	Number of fruits formed	Percentage of fruit setting	Seed range
Long-styled	129	43		
	33	4		
	17	0		
	45	0		
Total	224	47	20.98	5–15
Mid-styled	50	46		
	25	25		
	35	35		
Total	110	106	96.36	15–20
Short-styled	40	40		
	69	52		
	108	68		
Total	217	160	73.73	12–20
B SELFING WITH POLLEN FROM SHORTER STAMENS OF SAME FLOWER				
Long-styled	60	0	0	0
Mid-styled	70	64	91.04	12–20
Short-styled	45	40		
	20	10		
	65	50	76.92	10–20

The above data show that in *B. candolleanum,* the 3 forms of flowers have self sterility in varying degree. The mid-styled form is relatively unspecialised, being fully self-fertile. Short-styled form is also very highly self compatible. Maximum self incompatibility is found in the long-styled form. The unspecialised mid-styled form does not show specificity to type of pollen received; pollen from both sets of stamens are equally effective. But in long-styled flowers, pollen from shorter stamens is totally ineffective.

In heterostylous plants self-pollination is called 'illegitimate' (Darwin 1865). In *Lythrum salicaria,* several tristylous species of *Oxalis,* and many distylous species, the morphological adaptation for cross-pollination is reinforced by incompatibility system, preventing fertilization after illegitimate pollinations. But in some plants such incompatibility does not accompany heterostyly (Hildebrand 1887; Ray & Chisaki 1957). In *B. candolleanum,* there is an incompatibility system, though not perfect. The long-styled form is highly self-incompatible.

CROSS-POLLINATIONS

Pollination between anther and stigma at the same level in different forms of flowers is called 'legitimate' (Darwin 1865), because it is believed that heterostyly is an adaptation to promote cross breeding in hermaphrodite flowers and that such pollinations are the most productive. Where pollen grains of the different sets of anthers are markedly different in morphology, it is easier to find out which type of pollen falls on a stigma. But in *B. candolleanum* it is difficult because the pollen grains show a gradation in size. So crossing was conducted to determine the productivity of pollen from different sets of anthers. Results of some legitimate and illegitimate crosses are given below.

A LEGITIMATE CROSS

Type of cross	Number of pollination	Number of fruits formed	Seed range
Long-styled flower as seed parent			
Long style × Long stamen of short	31	25	
	20	20	
	35	35	
Total	86	80	12–15
Long style × Long stamen of mid	40	40	
	39	39	
Total	79	79	15–25
Mid-styled flower as seed parent			
Mid-style × Mid stamen of long	40	40	
Mid-style × Mid stamen of short	58	54	15–25
Short-styled flower as seed parent			
Short-style × Short stamen of long	60	44	
Short-style × Short stamen of mid	40	28	15–20

From the above data it is evident that *B. candolleanum* is similar to *B. sensitivum* DC. in legitimate crosses. In natural populations there is apparently little difference in the rate of fruit and seed setting between the 3 types of flowers. The comparatively lower rate of fruiting observed in short-styled form in artificial legitimate crossing may possibly be due to imperfection of pollen transfer. In these flowers styles curve out and bend down so that the stigmas are horizontal or even facing down. In emasculated flowers this curving is even more. In hand pollination it is probable that enough pollen grains do not stick on to the stigmas.

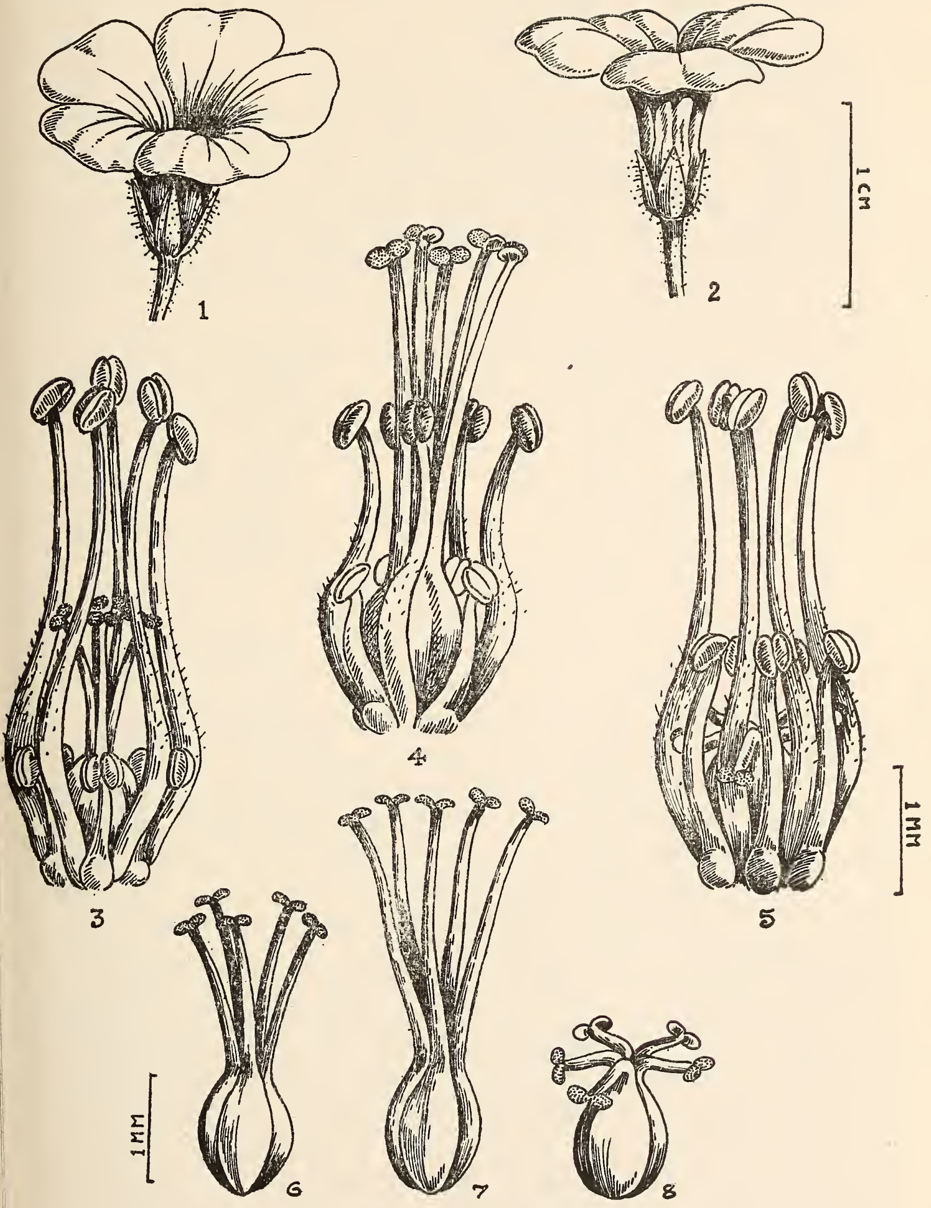
B ILLEGITIMATE CROSSES

Type of cross		Number of pollinations	Number of fruits	Seed range
Long-styled flower as seed parent.				
Long style × Short stamen of mid		60	0	
Long style × Short stamen of short		21	7	
		30	1	
		40	7	
	Total	91	15	8–12
Long style × Mid-stamen of long		49	6	
Mid-styled flower as seed parent				
Mid-style × Long stamen of short		29	27	
Mid-style × Long stamen of mid		50	45	
Mid-style × Short stamen of long		28	25	
Mid-style × Short stamen				
Short-style flower as seed parent				
of short		30	29	15–25
Short-styled flower as seed parent				
of long		46	36	15–20
Short style × Mid stamen of mid		46	20	15–20

Percentage of seed formation with respect to pollination was not determined, though the range of variation in number of seeds was noted. It is found that the number of ovules is not constant in all ovaries of even the same type of flower. It varies from 15 to 30. Occasionally, aborted ovules are also seen. Hence, determination of fertility on the basis of number of seeds could be exact only when large number of pollinations are considered. Ready setting of fruits with well formed seeds has therefore been taken as indicating compatibility.

Pollination experiments show that *B. candolleanum* is slightly different from *B. sensitivum* DC. in the case of illegitimate crosses. Short-styled form of *B. sensitivum* DC. is reported to be self compatible only in low degree (Mayura Devi 1964), whereas in *B. candolleanum,* self compatibility is more than 70 per cent. Mid-styled form of this species is even more self compatible than in *B. sensitivum* DC. and unlike in

Nair: *Biophytum candolleanum*



Biophytum candolleanum Wt.

Fig. 1 & 2, Open flowers; Figs. 3, 4, 5, essential organs of mid, long and short-styled flowers; Figs. 6, 7, 8, gynoetium of mid, long and short-styled flowers.

the latter, there is little difference in the productivity of pollen from long and short stamens in selfing. That the mid-styled flower of *Biophytum* is comparatively unspecialised in breeding habits, seems to be supported by the behaviour of the closely allied species *B. reinwardtii* Edgw. & Hook. f.

Specimens of *B. reinwardtii* Edgw. & Hook. f. were collected from Vadakumpad village, Tellicherry, Kerala, in July 1970. The species was identified at Kew, based on herbarium specimens and flowers kept in liquid preservative. This species is very much like *B. sensitivum* DC. in morphology, but smaller, weaker and of shorter duration. It is more susceptible to fungal diseases. Approximate measurements in mm of floral parts are given below.

Length of peduncle	up to 100
Length of pedicel	5-6
Diameter of corolla	7-10
Length of corolla	7-9
Length of sepals	3
Width of petal	4 at apex
Length of stamen:	
Long stamen	2-3
Short stamen	1
Length of pistil	2

In spite of the close similarity to *B. candolleanum* this species is remarkable in its breeding habits. Two populations were observed, collecting more than 100 plants from each. All these plants were of the same kind, being very similar to the midstyled flower of *B. candolleanum* but the styles slightly shorter. Typical long and short-styled forms were not found. The erect styles are held at an angle of about 45° so that their stigmas are just above the short stamens or even touching their anthers. Because of this, at anthesis the stigmas get a good supply of pollen from the short stamens. If this pollen is productive as in *B. candolleanum*, there is no need of insect agent for pollination in this species. To ascertain this, inflorescence were bagged for days on end. Of the 100 flowers which opened inside bags, 96 formed well developed fruits with number of seeds ranging from 20 to 30. Then, 100 bagged flowers were self pollinated with pollen from the long stamens. All of them set fruits, with 20-30 seeds in each. From these observations it is clear that *B. reinwardtii* is a totally self compatible species which is also remarkable in being adapted for self pollination.

B. reinwardtii also shows partial compatibility with *B. candolle-*

anum . Results of some crosses between these two species are as shown below.

Seed parent		Pollen parent	No. of flowers pollinated	No. of fruits	Average No. of seeds
B. candolleanum		*B. reinwardtii*			
Long style	×	Long stamen	125	0	0
Mid style	×	Long stamen	33	17	12.64
Short style	×	Long stamen	21	6	10
B. reinwardtii		*B. candolleanum*			
,,	×	Mid stamen of Long	30	15	16
,,	×	Long stamen of Mid	28	16	12.75
,,	×	Long stamen of Short	24	7	18.4

When long-styled flower of *B. candolleanum* is selected as seed parent, total incompatibility is observed, though cross may be said to be legitimate. But the mid and short-styled flowers show compatibility to some extent. Reciprocal crosses with *B. candolleanum* as pollen parent also show compatibility in varying degree. However, to arrive at definite conclusions further investigation is required.

SUMMARY AND DISCUSSION

Results of artificial breeding in *B. candolleanum* indicate the presence of incompatibility system associated with tristyly and varying in degree. Long-styled form is highly self incompatible. Mid-styled form is totally self compatible. Short-styled form is also very highly self-fertile. Maximum self sterility is seen in the form which has the stigmas far above all the anthers. Forms with at least one set of anthers above the stigmas are highly self fertile.

B. reinwardtii is adapted for self pollination and is totally self fertile. In this species the long and short-styled forms seem to have disappeared, leaving only the mid-styled form with necessary modifications to ensure self pollination.

Mather & de Winton (1941) are of the opinion that incompatibility reaction and morphological dimorphism arose together as one inseparable unit and not as distinct outbreeding mechanisms which are found together because of mutual reinforcement. But this conclusion has since been proved unacceptable. It is generally assumed that a homomorphic multiallelic incompatibility system is primarily in angiosperms (Stebbins 1947, 1950, 1960; Whitehouse 1950; Crowe 1964). Heterostyly which is found in more advanced taxa is believed to be derived from an ancestral multiallelic system either by degeneration of all except two alleles or by the degeneration of all alleles and subsequent rise of a diallelic system and or heteromorphy (Vuilleumier 1964). According to Crowe (1964) heterostyly is "a degenerate form of homomorphic incompatibility from which it arise by loss of alleles." But this view is not accepted by Vuilleumier who on the basis of available evidence suggests that as alleles were lost homomorphic species became self fertile and possibly subsequently lost all incompatibility alleles later when environmental conditions changed, outbreeding in some taxa could have again been selected for and diallelic system evolved. Ornduff (1964) also supports this view.

Earlier investigators like Hildebrand (1867) and Darwin (1877) considered that heterostyly originated as adaptation to specialised insect visitors which would transfer pollen from a given anther level to stigmas of same level in other flowers, thus effecting cross pollination. The expectation is that the same part of the body of the insect would touch the anthers and stigmas at the same level in different flowers. But this could hardly be an exact mechanism to ensure cross breeding. It is more a theoretical possibility than a practical certainty. Moreover in flowers with one set of anthers above the stigmas, visit of insect is likely to cause shedding of some pollen from these anthers on the stigmas below. Such flowers would therefore be getting a mixture of own and foreign pollen. This possibility would defeat the purpose of heterostyly as an adaptation for cross pollination. A better and surer mechanism would be required to ensure out breeding. Incompatibility system might have developed for this. Morphological heteromorphism reducing chances of a stigma getting own pollen could have led to physiological specialisation and brought in an incompatibility system in course of time. In *B. candolleanum* while morphological heteromorphism is complete, incompatibility system is not so perfect, probably showing that the latter is a secondary modification. The long-styled flower which has least chance of getting own pollen is also the most self incompatible.

If homomorphic multiallelic incompatibility system is the primitive condition, origin of heterostyly would appear to be an accident rather than a definite adaptation. Self incompatibility itself being a sure mechanism preventing in breeding, there is no need for a less effective adaptation. It is not reasonable to assume that such an unnecessary adaptation appeared in so many families. That heterostyly may lead to unisexuality or break up by losing one or more floral forms has been shown by Ornduff (1964) in *Oxalis suksdorfii* and species of *Nymphoides*. Such a loss of floral forms seems to have taken place in *B. reinwardtii*. Adaptation for self pollination is a derived condition in this; otherwise the floral organisation could have been simpler.

ACKNOWLEDGEMENTS

I am deeply indebted to Dr. Robert Ornduff, University of California, for initiating me into the study of heterostyly, giving me reprints of many papers on the subject and helping me with valuable advice. I am also obliged to Mr. K. Sasidharan, Lecturer, Govt. College, Madappally, for getting me literature on *B. sensitivum* and helping me collect plants.

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Observations on systematics of Sessile Barnacles from West Coast of India-1[1]

BY

ARUN B. WAGH[2] AND D. V. BAL[3]

(*With ten text-figures*)

INTRODUCTION

Studies on systematics of any group of animals is an essential prerequisite for bio-ecological investigation. The present studies were undertaken with this view and have been followed by investigations on various aspects of bio-ecology of barnacles which are being published elsewhere.

MATERIAL AND METHODS

The present paper contains a description of sessile barnacles collected from the coast of Maharashtra which is the area lying between 20°05′N to 15°48′N on the west coast of India. The collections were made from the intertidal region.

The usual method of treating the valves, compartments, mouthparts and other appendages of the specimens with caustic potash, was employed. For staining, borax-carmine as well as picro-indigocarmine stains were used. The diagrams were drawn with the aid of camera lucida.

OBSERVATIONS

A classified list of the various forms described is as follows:

Sub-order BALANOMORPHA Pilsbry, 1916.

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[3] Kirti College, Bombay 400 028.

Family CHTHAMALIDAE Darwin, 1854.
Genus *Chthamalus* Ranzani, 1817.
1. *Chthamalus malayensis* Pilsbry, 1916.
2. *Chthamalus withersi* Pilsbry, 1916.
Family BALANIDAE Gray, 1925.
Sub-family Balaninae Darwin, 1854.
Genus *Balanus* Da Costa, 1778.
Sub-genus *Megabalanus* Hoek, 1913.
3. *Balanus tintinnabulum* var. *tintinnabulum* Linne, 1758.
Sub-genus *Balanus* Da Costa, 1778.
4. *Balanus amphitrite* var. *communis* Darwin, 1854.
5. *Balanus amphitrite* var. *venustus* Darwin, 1854.
6. *Balanus amphitrite* var. *stutsburi* Darwin, 1854.
7. *Balanus amphitrite* var. *hawaiiensis* Broch, 1922.
Sub-genus *Chirona* Gray, 1835.
8. *Balanus amaryllis* Darwin, 1854.
forma *euamaryllis* Broch, 1922.
Sub-family Chelonibiinae Pilsbry, 1916.
Genus *Chelonibia* Leach, 1817.
9. *Chelonibia testudinaria* Linne, 1758.
10. *Chelonibia patula Ranzani,* 1818.
Sub-family Tetraclitinae Nilsson-Cantell, 1921.
Genus *Tetraclita* Schumacher, 1817.
11. *Tetraclita* (*Tetraclitella*) *purpurescens* Wood, 1818.

SPECIES DESCRIPTION

Chthamalus malayensis Pilsbry, 1916. (Figure 1)

Remarks: The specimens conforming to both types, namely *Ch. malayensis* as well as *Ch. moro* were collected. However, all the forms have been described as *Ch. malayensis* because the view point of Utinomi (1954) and Karande & Palekar (1963) is being followed.

Colour of the shell, externally, varies from light brown to grey-brown. Some forms exhibited slightly greenish tinge. The diameter of the shell varies from 5-6 mm to 10-12 mm. Opercular valves resemble with those described by Utinomi (1954). Tergum bears 4-5 short crests for the attachment of depressor muscles.

Mandible possesses 3 or 4 teeth. The row of spines below the fourth tooth consists of 10-14 spines. Maxilla has three upper spines which are separated by a small notch from the lower spines. Hairy labrum bears 16-17 teeth out of which first two are comparatively longer and more stout. Cirrus II is with both, toothed and serrated types of spines.

Localities: Bombay (north and south), Alibag, Murud-Janjira, Shri-

wardhan, Harnai, Ladghar, Jaigad, Nandivade, Ganapati-Pule, Ratnagiri, Vijaydurg, Deogad, Malvan, Vengurla, Redi.
Distribution: Indian Ocean and Malay Archipelago.

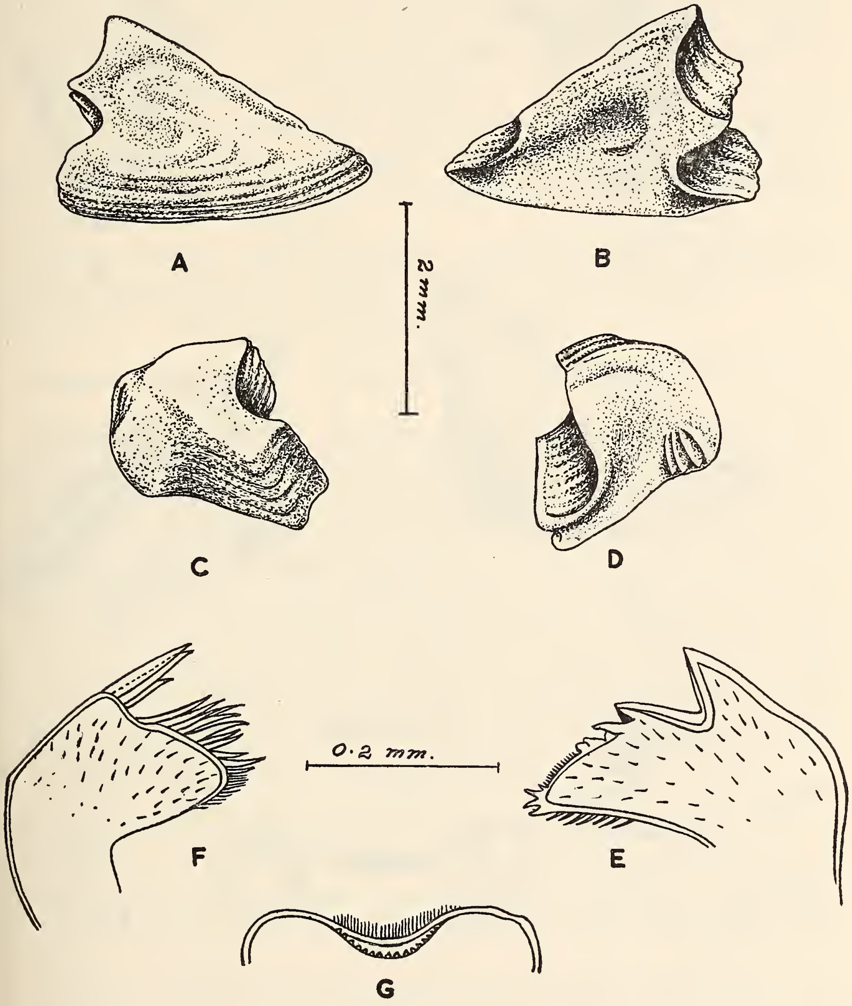

Fig. 1. *Chthamalus malayensis* Pilsbry

Opercular valves and mouth-parts

A. Scutum — outer view; B. Scutum — inner view; C. Tergum — outer view; D. Tergum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labail palps not shown).

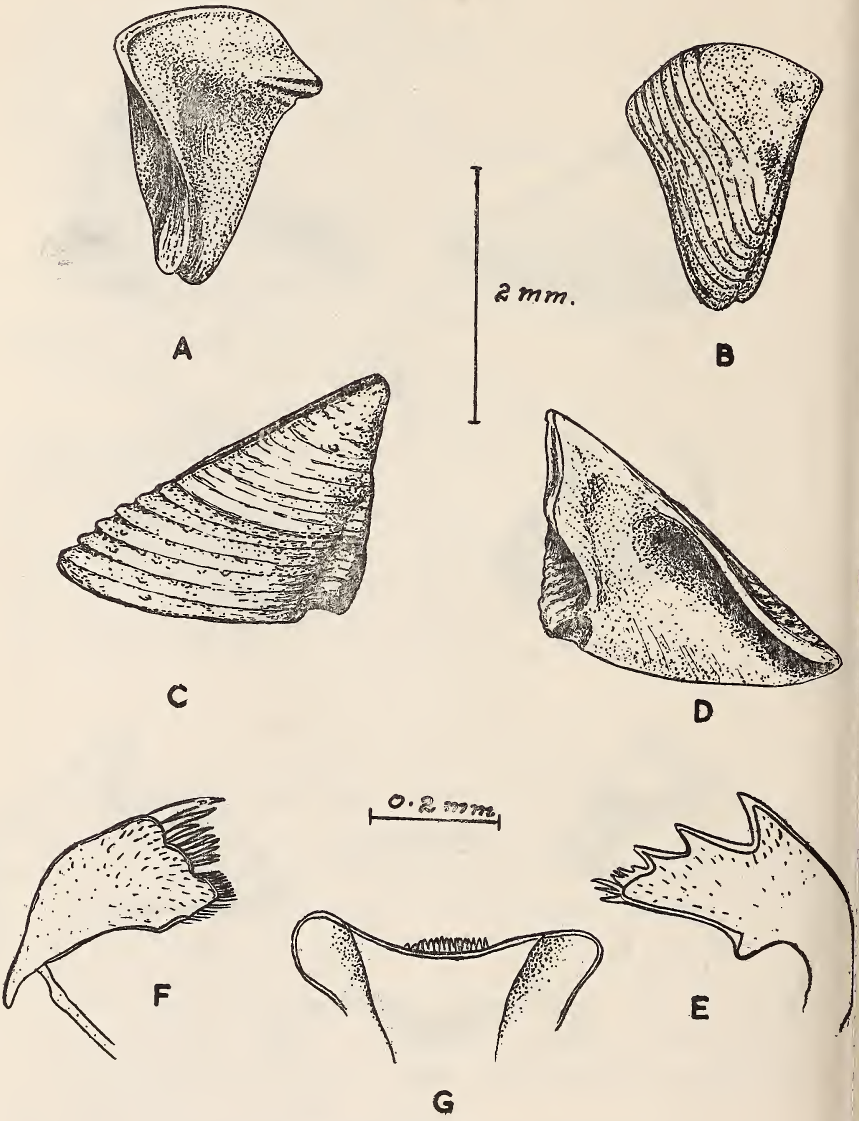

Fig. 2. *Chthamalus withersi* Pilsbry

Opercular valves and mouth parts

A. Tergum — inner view; B. Tergum — outer view; C. Scutum — outer view; D. Scutum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

Chthamalus withersi Pilsbry, 1916. (Figure 2)

Remarks: Colour, dirty brown or dirty grey. Carino-rostral diameter 6-7 mm. Compartments without ridges, with simple sutures and broad alae. The description of opercular valves generally agrees with that given by Nilsson-Cantell (1938). Thus, spur is almost united with the basi-scutal angle. Similarly, the narrow carinal lobe with few crests for the depressor muscle is also found to be present. Scutum, however, bears a distinct pit for the lateral depressor muscle and thereby differs from that described by Nilsson-Cantell.

Mandible bears 3 teeth and a pecten of 6-7 spines. Edge of maxilla has two notches thereby dividing the spines into three groups. Out of them, upper two spines look more stout. Labrum bears numerous minute teeth.

Localities: Bordi, Gholvad, Bassein, Bombay (south), Elephanta, Anjarle, Ganapati-Pule, Ratnagiri, Deogad, Malvan, Shiroda.

Distribution: Indian Ocean, Malay Archipelago.

Balanus tintinnabulum tintinnabulum Linne, 1758. (Figure 3)

Remarks: The present collection contains two different sets of individuals. Those collected from Madh Island, Bandra and Chowpatty rocks (all grouped under Bombay) have blackish purple compartments that are moderately ribbed longitudinally and with conical shape. The specimens collected at other localities have tubulo-conical shells; the compartments smooth and purplish-pink in colour. Shell-walls and the opercular valves of the former are quite thick as compared to those of the latter. Size of the shells varies from 35 mm to 60 mm in their basal diameters. Opercular valves agree with those described by Hiro (1939). The scutum, however, shows a slight difference by possessing a well-developed pit for the lateral depressor muscle.

Mandible has 5 teeth, of which, the second and third are bifid. Maxilla I has a straight edge with its spines arranged in three groups. Labrum shows 1-2 teeth on either side of the median notch.

Localities: Bombay, Murud-Janjira, Harnai, Ladghar, Nandivade, Ganapati-Pule, Ratnagiri, Vijaydurg, Mumbri, Malvan, Vengurla and Redi.

Distribution: Definitely known from Mediterranean sea, Atlantic and Indian Ocean.

Balanus amphitrite communis Darwin, 1854. (Figure 4)

Remarks: Coloration of shell shows a great degree of variation. Most of them have pink coloured stripes whereas some exhibit dark brown stripes. Shape of shell conical, but a few of them were tubulo-conical, probably due to crowding.

Scutum is reddish brown externally and bears a conspicuous white stripe along its tergal margin. Mandible has 5 teeth of which the fourth and fifth are small and knob-like. Maxilla I has a straight edge. Labrum deeply notched with teeth on either side of it, numbering from 4 to 8. Some workers are of the opinion that multi-denticulated forms should be grouped under variety *denticulata*. However, Nilsson-Cantell (1938), Tarasor and Zerina (1957) have grouped even multidenticulate forms

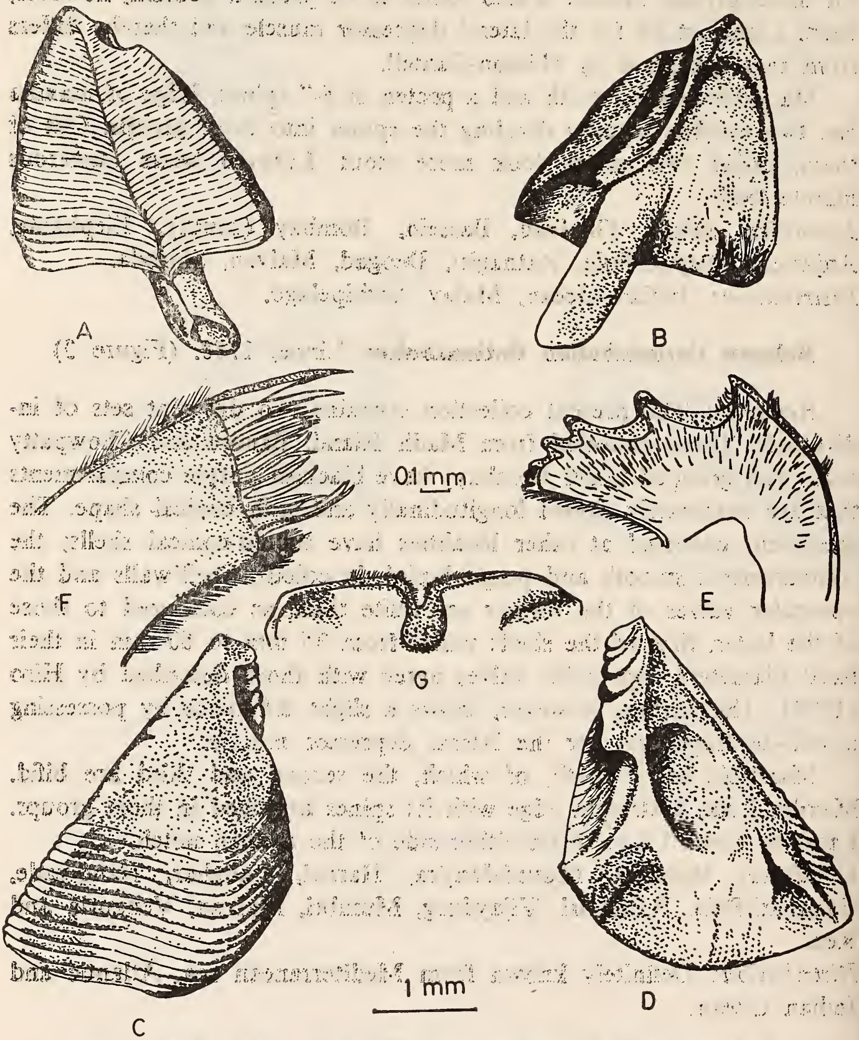

Fig. 3. *Balanus tintinnabulum tintinnabulum* Linn.

Opercular valves and mouth parts

A. Tergum — outer view; B. Tergum — inner view; C. Scutum — outer view; D. Scutum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

under var. *communis* on the contention that it is merely a minor variation which does not warrant the creation of a separate variety. In the present investigations the latter view has been accepted.

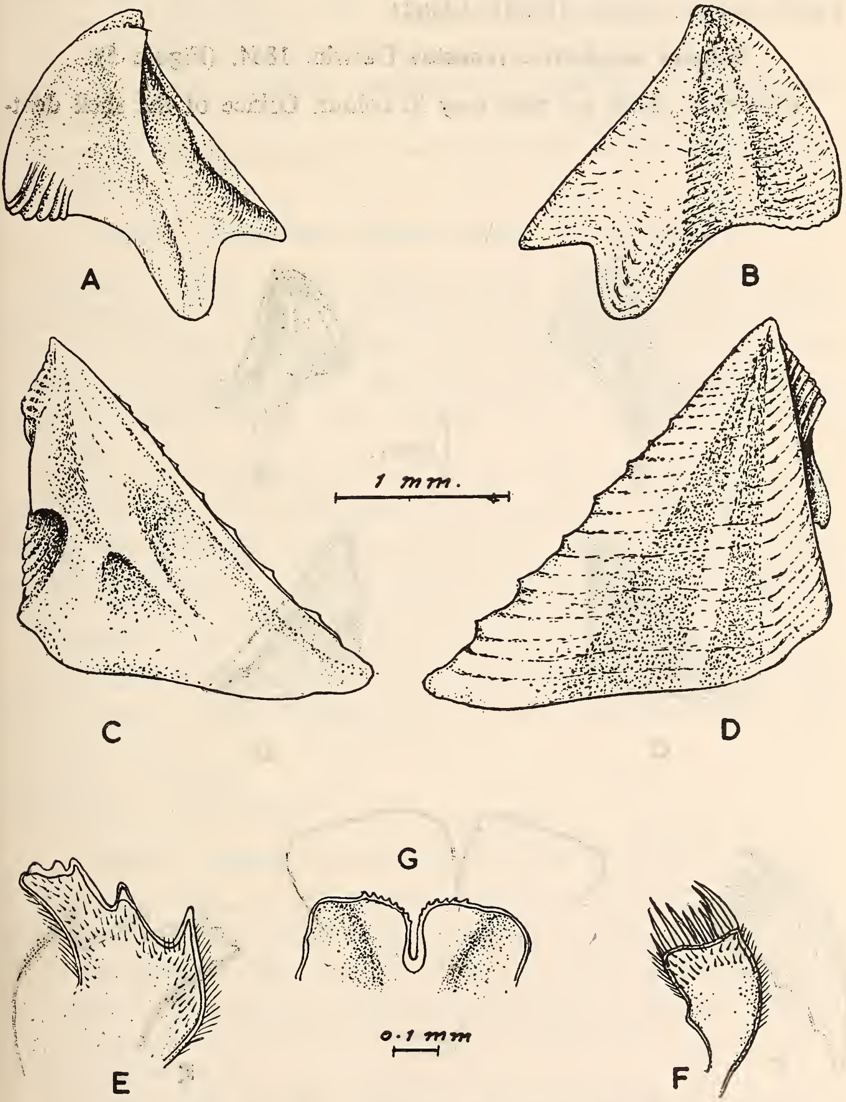

Fig. 4. *Balanus amphitrite communis* Darwin
Opercular valves and mouth parts

A. Tergum — inner view; B. Tergum — outer view; C. Scutum — inner view; D. Scutum — outer view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

Localities: Bombay, Elephanta, Alibag, Shriwardhan, Harnai, Dabhol, Jaigad, Nandivade, Ganapati-Pule, Ratnagiri, Vijaydurg, Deogad, Malvan, Vengurla, Tak, Shiroda and Redi.

Distribution: West India, European waters, Mediterranean, west and south Africa, Indian Ocean, Malay Archipelago, New South Wales, Pacific Ocean, Japan, Hawaii Islands.

Balanus amphitrite venustus Darwin, 1854. (Figure 5)

Remarks: Shells are pale rosy in colour. Orifice of the shell dent-

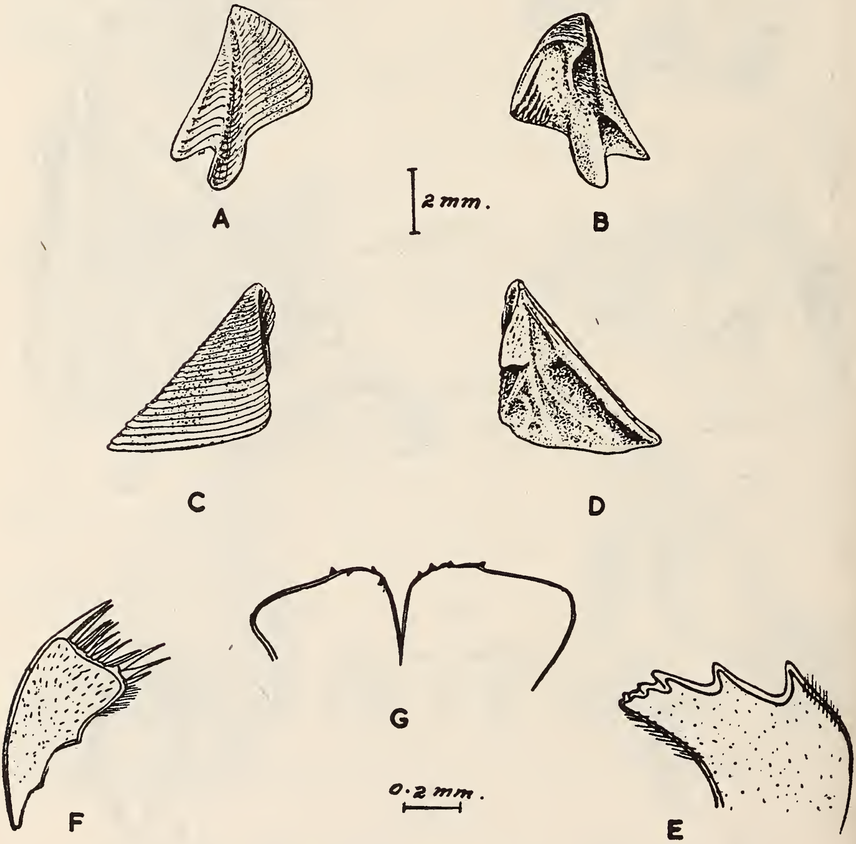

Fig. 5. *Balanus emphitrite venustus* Darwin

Opercular valves and mouth parts

A. Tergum — outer view; B. Tergum — inner view; C. Scutum — outer view; D. Scutum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

ated. Radii are narrow with their summits parallel to the base. Tergum possesses a broad, inclined spur with rounded head. Basi-scutal angle is quite acute, thereby giving it a pointed appearance. Scutum is very thin and bears a well-developed articular ridge. Mandible has 5 teeth of which the fourth and fifth are knob-like. Maxilla I has almost a straight edge bearing two pairs of long spines with 7 smaller spines in between them. Labrum with a deep and narrow median notch. On either side of the notch are 4 teeth.

Localities: Bandra, Jaigad, Ganapati-Pule, Ratnagiri, Vengurla and Shiroda.

Distribution: Mediterranean sea, west and south Africa, Indian Ocean and Japan.

Balanus amphitrite stutsburi Darwin, 1854. (Figure 6)

Remarks: About twelve specimens settled on a wooden test panel were collected at Trombay (Bombay). They are all 'typical *stutsburi*' forms. As described by Stubbings (1961) the shell is conical and has a robust appearance. There is also incurving of the compartments towards the shell opening, so that the shell presents a convex appearance in profile.

Tergum is of typical shape with its spur very much elongated. The longitudinal furrow is represented by a depression. The basi-carinal lobe is well-developed and bears on its inner surface crests for tergal depressors. Scutum has well-developed, adductor as well as articular ridge. Pit for the lateral depressor is quite pronounced.

Mandible bears 5 teeth and 2-3 spinelike projections at its lower angle. Maxilla I has the lower part of its edge slightly protruded which in turn carries a pair of long spines. Labrum has deep median notch with 3-4 teeth on either side of it.

Localities: Trombay.

Distribution: West Africa.

Balanus amphitrite hawaiiensis Broch, 1922. (Figure 7)

Remarks: Colour of the shell dirty white with violet vertical stripes. Shell has a large rhomboid orifice and thick compartments. Apex of the rostral plate is either straight or slightly incurved. The opercular valves agree in appearance with those described by Utinomi (1960). The suture between two opercular valves of the same side present a sinuous appearance.

Mandible bears 5 teeth. Maxilla I is of the typical *B. amphitrite* shape. Labrum bears numerous teeth on either side of the notch. Based on this character alone, Broch (1922) created variety *denticulata*. However, as stated previously, it is being treated as minor variation in the present communication and hence the forms are assigned either

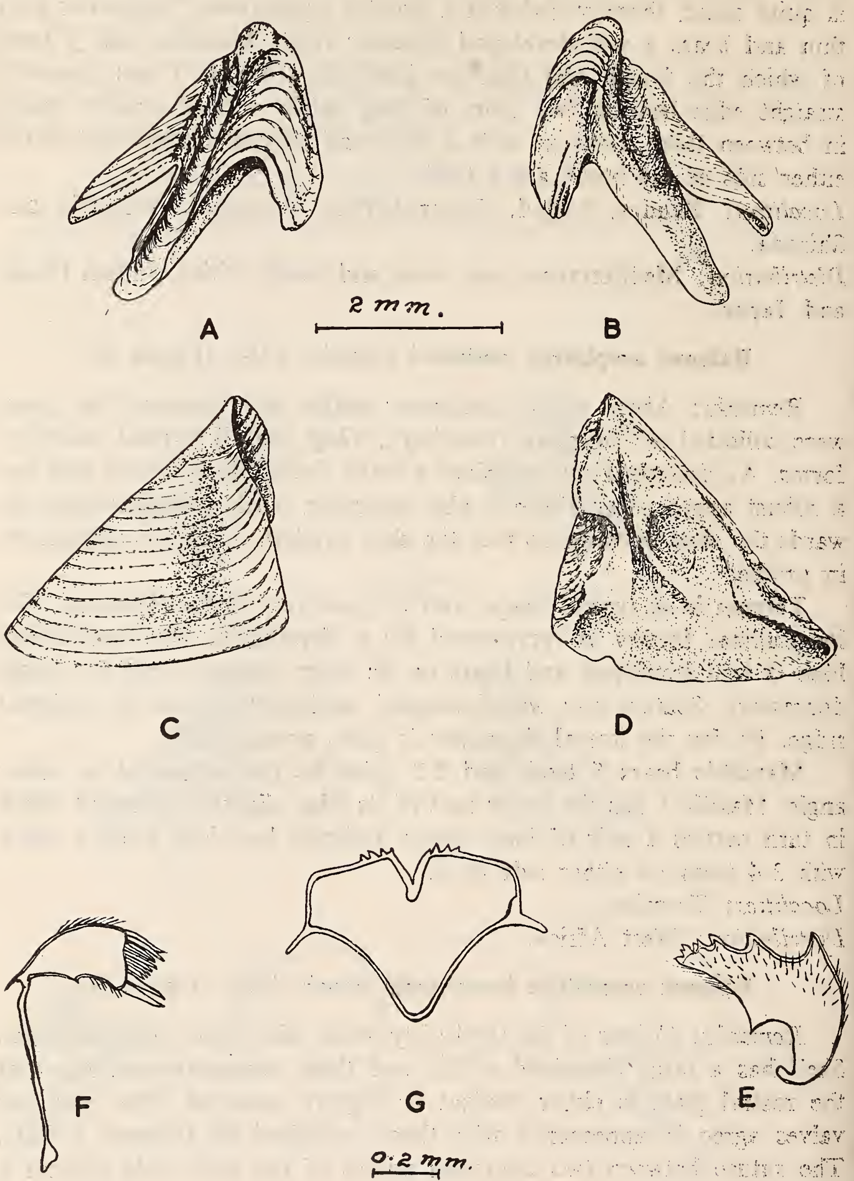

Fig. 6. *Balanus amphitrite stutsburi* Darwin

Opercular valves and mouth parts

A. Tergum — outer view; B. Tergum — inner view; C. Scutum — outer view; D. Scutum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

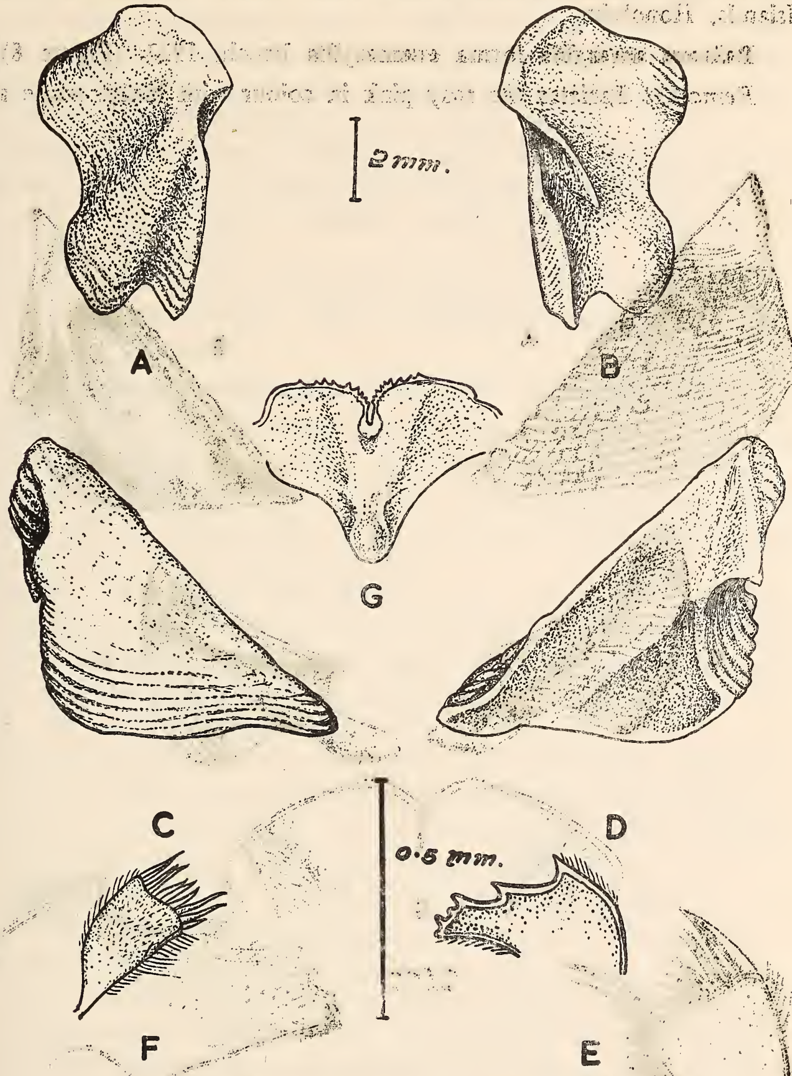

Fig. 7. *Balanus amphitrite hawaiiensis* Broch
Opercular valves and mouth parts

A. Tergum — outer view; B. Tergum — inner view; C. Scutum — outer view; D. Scutum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

to *communis* or *hawaiiensis* variety depending upon their entire set of characters.

Localities: Gholvad, Bombay, Elephanta, Dabhol, Harnai, Tak and Aronda.

Distribution: Indian Ocean, Persian Gulf, Malay Archipelago, Hawaii Islands, Honolulu.

Balanus amaryllis forma **euamaryllis** Broch, 1922. (Figure 8)

Remarks: Parietes are rosy pink in colour with bluish white alae.

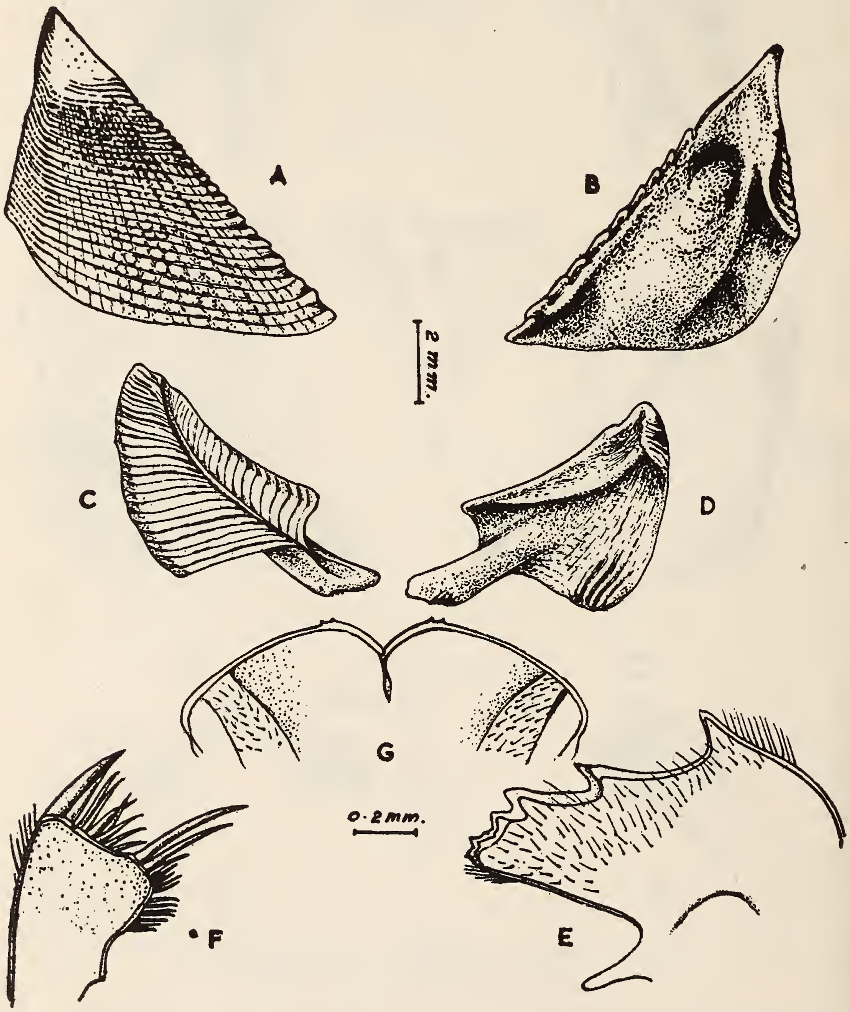

Fig. 8. *Balanus amaryllis* Darwin forma *euamaryllis* Broch

Opercular valves and mouth parts

A. Scutum — outer view; B. Scutum — inner view; C. Tergum — outer view; D. Tergum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

Radii are oblique and are covered by persistent yellow epidermis. Alae are comparatively broader.

Tergum externally bears a deep longitudinal furrow which is closed in fully grown specimens. Spur is long and narrow with its end bluntly pointed. Scutum is plainly striated longitudinally, with the striae dividing the lines of growth into squarish beads. Depression for the attachment of lateral depressor muscle is quite deep.

Mandible bears 5 teeth of which the second one is large and double. Maxilla I bears a pair of long spines at the apex and another pair at base with 7 shorter spines in between. Labrum has 2-3 small teeth on either side of the notch.

Localities: Cuffe Parade, Chowpatty, Breach Candy, Manori.

Distribution: Indian Ocean, Malay Archipelago, China, Japan, northern coast of Australia.

Chelonibia testudinaria Linne 1761. (Figure 9)

Remarks: Fourteen specimens were obtained from the back of a sea-turtle (*Eretmochelys imbricata*) that was brought to the Taraporevala Marine Biological Station, Bombay. All the specimens were fairly well-developed and had attained large size; some of them admeasuring 45 mm in their rostro-carinal diameter.

Remarks: Shell much depressed and oval in outline. Colour dirty white. Parietes are thick with numerous vertical plates extending from the outer lamina towards the inner lamina. Radii are narrow. A hard, yellow and horny membrane representing the articular ridge of the tergum unites the tergum and scutum.

Labrum bears numerous teeth on either side of the notch. Mandible has 5 teeth of which the second and third are double. Lower angle of mandible is pectinated. Maxilla I is without any notch and its straight edge bears 15-16 spines without any definite pattern.

Distribution: Tropical and temperate seas, attached to turtles.

Tetraclita (Tetraclitella) purpurascens Wood, 1818. (Figure 10)

Remarks: Shell coloration of these forms is dirty brown or greenish in the field. However, on cleaning the shell it becomes white or greyish white. Shell is much depressed with 22-28 ribs on its outer surface. Compartment walls are thick with parietal tubes arranged in rows. Radii are broad with horizontal summits.

Scutum transversely elongated and with the pit for depressor muscle being indistinct. Tergum has extremely short spur that is situated very close to basi-scutal angle. Crests for the depressor muscle well-developed and are six in number.

Mandible bears 5 teeth with third and fourth being double. The lower angle is pectinated. Maxilla I slightly notched.

Localities: Bombay-Cuffe Parade, Madh Island, Breach Candy.

Distribution: Madagascar, Malay Archipelago, China and India.

Chelonibia patula Ranzani, 1820.

Four specimens were found attached to a spiny lobster, *Panulirus polyphagus* (Herbst).

Remarks: Shell is light, fragile and loosely cemented. Radii are broad and smooth. The opercular valves are very much similar to those of *Chelonibia testudinaria* but narrow comparatively.

Distribution: Atlantic Ocean, Mediterranean Sea, Indian Ocean, Malay Archipelago, Pacific Ocean.

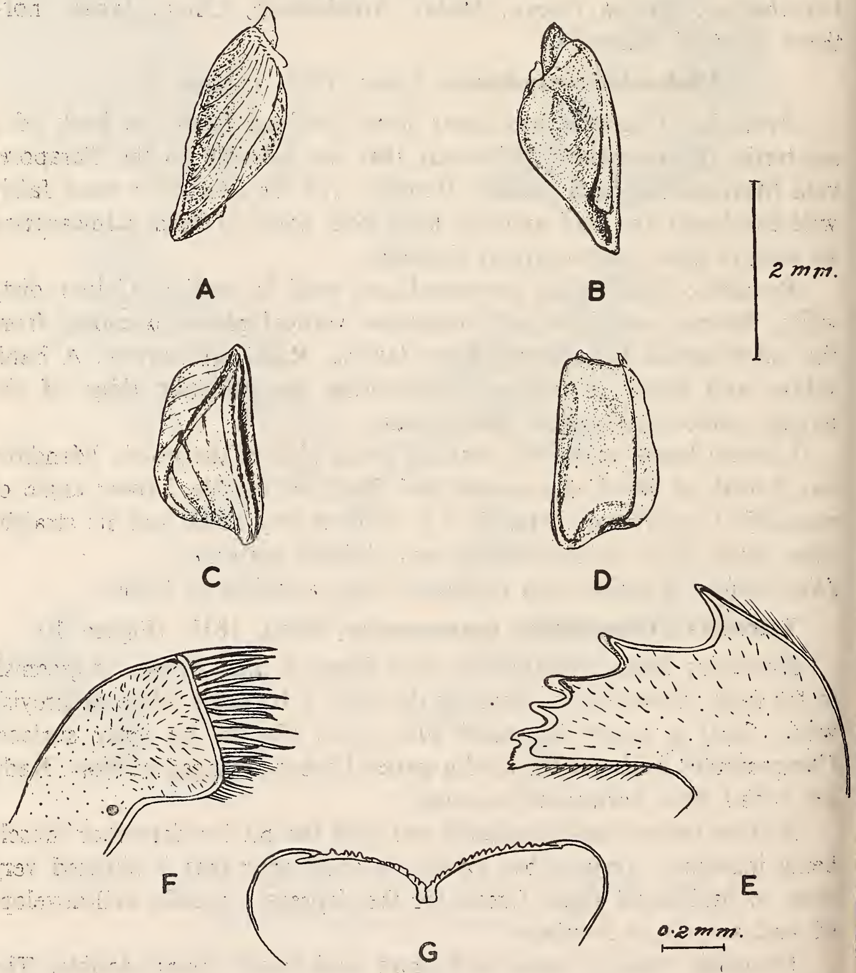

Fig. 9. *Chelonibia testudinaria* Linn.

Opercular valves and mouth parts.

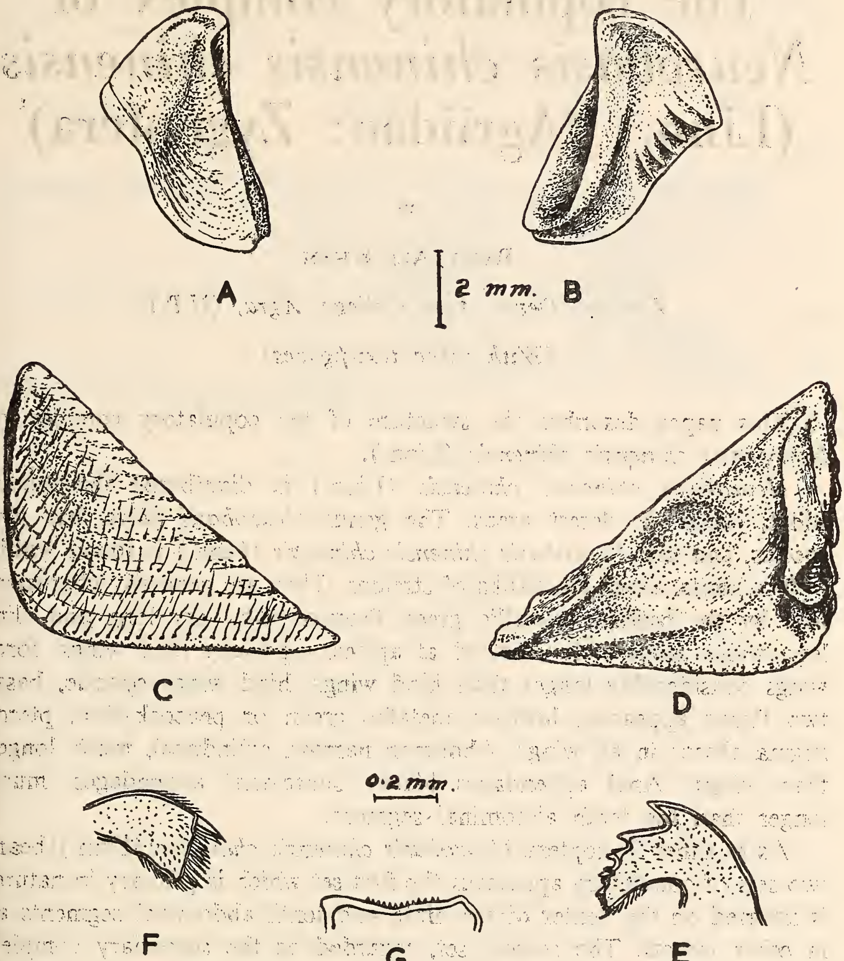

Fig. 10. *Tetraclita* (*Tetraclitella*) *purpurescens* Wood
Opercular valves and mouth parts.

Key to abbreviations for Figs. 9 & 10.

A. Tergum — outer view; B. Tergum — inner view; C. Scutum — outer view; D. Scutum — inner view; E. Mandible; F. Maxilla I; G. Labrum (labial palps not shown).

(*to be continued*)

The copulatory complex of *Neurobasis chinensis chinensis* (Linn.) (Agriidae: Zygoptera)[1]

BY

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(*With three text-figures*)

This paper describes the structure of the copulatory complex of *Neurobasis chinensis chinensis* (Linn.).

Neurobasis chinensis chinensis (Linn.) is distributed throughout India, except in desert areas. The genus *Neurobasis* Selys, has two species, and one *Neurobasis chinensis chinensis* (Linn.) is found within Indian limits, along the banks of streams. They are generally characterised by the brilliant metallic green thorax, with very long and slim legs, wings moderately rounded at apices, especially hind wings, forewings considerably longer than hind wings, hind wings opaque, basal two thirds appearing brilliant metallic green or peacock-blue, pterostigma absent in all wings. Abdomen narrow, cylindrical, much longer than wings. Anal appendages black, supra-anal appendages much longer than the tenth abdominal segment.

As in other Zygoptera *Neurobasis chinensis chinensis* (Linn.) bears two sets of copulatory apparatus the first set which is primary in nature, is situated on the venter of the ninth and tenth abdominal segments as in other insects. The second set, regarded as the secondary complex is located ventrally on the entire second and the apical part of the third abdominal segments.

The first set is used for holding the female during copulation while the second set is used in actual coition.

PRIMARY COPULATORY COMPLEX

Fig. 1.

The primary copulatory complex consists of a median vestigial

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or primitive penis (VP), a pair of reduced appendages or gonocoxites (C) (=gonapophyses, Fraser 1956; gonopods, Snodgrass 1935; coxites, George 1928; valvules, Whedon 1918), a pair of supra-anal appendages (SAA) (=cerci, Snodgrass 1935), and a pair of infra-anal appendages (IAA) (=cerci, Fraser 1956; epiproct, Snodgrass 1935).

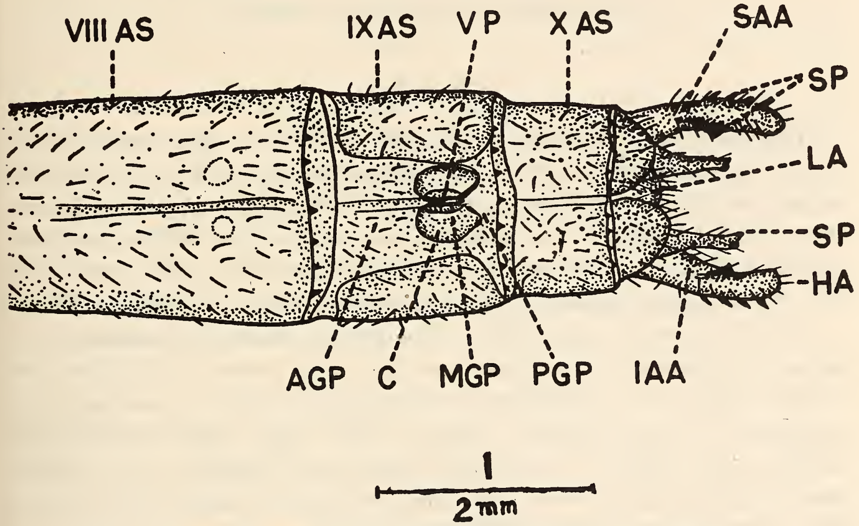

Fig. 1. Ventral view of the primary copulatory complex.

(i) *Vestigial penis* (VP).—The vestigial penis is represented by a reduced sclerite situated almost in the middle of the ventral surface of the ninth abdominal segment (AS). The vestigial penis has an elongated opening, the male gonopore (MGP) (=genital meatus, Fraser 1956).

(ii) *Coxites* (C).—The male gonopore (MGP) and the vestigial penis (VP) are guarded laterally by a pair of reduced, oval appendages or gonocoxites. The portions of the ninth sternum lying anterior and posterior to the male gonopore are modified to form the anterior and posterior genital plates (AGP & PGP) respectively. The anterior genital plate (AGP) is comparatively well developed.

(iii) *Supra-anal appendages* (SAA).—The supra anal appendages arise from the terminal end of the tenth abdominal segment (AS) from its dorso-lateral sides. They are long, sub-cylindrical near the base, forcepate, and curved towards each other, with rounded and slightly flattened apices. Each supra-anal appendage bears many spines (SP) on the outer and lateral margins near the apex and a prominent conical projection on the inner and lateral side, heavily covered with hairs.

(iv) *Infra-anal appendages* (IAA).—The infra-anal appendages also arise from the terminal end of the tenth abdominal segment, and lie ventral to supra-anal appendages and lateral to anus. They are shorter than supra-anal appendages and broader proximally and narrower distally with blunt apices. The infra-anal appendages are widely separated at the base and covered with hairs and spines.

SECONDARY COPULATORY COMPLEX

Figs. 2 & 3.

The secondary copulatory complex consists of the genital fossa (GF) (=fenestra, Fraser 1956), the anterior lamina (AL), the posterior lamina, the lamina-batilliformis (LAB), the chitinous supporting framework (APSF & PPSF), the hamules, the penis vesicle (PV) (=vesicula spermalis, Fraser 1956; sperm-receptacle, Snodgrass 1935), the penis (P) (=prophallus, Fraser 1956; intromittent organ, Snodgrass 1935).

(i) *The genital fossa* (GF).—The genital fossa is a median, shallow and membranous depression on the entire second and apical part of third sterna. It is supported by three main sclerites. Anteriorly it is supported by the anterior lamina (AL), and lamina-batilliformis (LAB), posteriorly by a posterior lamina, and laterally by a complicated chitinous framework of sclerites. All the structures of the secondary complex are placed inside the fossa.

(ii) *Anterior lamina* (AL).—The anterior lamina is a chitinous, hood-like sclerite occupying the front part of the second venter and extending in between the two ventral margins of the second tergum. It is somewhat inverted V-shaped structure. The anterior margin of the anterior lamina (AL) is more or less straight and bears prominent laminar processes (LP), while the posterior margin is deeply notched. The inner and lateral walls of the notch are furnished with hairs and it encloses the proximal portion of the penis. The anterior lamina has two prominent borders, the inner border (IB) and the outer border (OB), the inner border is broader than the outer one.

(iii) *Lamina-batilliformis* (LAB).—The lamina-batilliformis is forceps-like chitinous structure lying inside the notch, in between the two arms of the inverted V-shaped anterior lamina (AL). According to Thompson (1908) the lamina-batilliformis may be regarded as penis sheath in Zygoptera, because it lies exactly in the same position as the penis sheath in Anisoptera and it also covers the proximal portion of the penis. The two arms (AR) of the lamina-batilliformis (LAB) are widely divergent, terminating into rounded apices and furnished with hairs.

(iv) *Posterior lamina*.—The posterior lamina is a simple chitinous plate, lying at the posterior end of the genital fossa. It is not visible externally, because it is completely covered by the anterior portion of the penis vesicle (PV).

(v) *Supporting frame-work* (APSF & PPSF).—The genital fossa (GF) is strengthened and supported by a number of chitinous rods, which together constitute the complicated net work of chitinous bars, the supporting frame-work. The supporting framework supports the various parts of the copulatory complex and also provides the various surfaces or facets for the articulation of the copulatory organs with each other.

It is divisible into two portions, the anterior portion (APSF) and the posterior portion (PPSF). The anterior portion of the supporting framework lies below the anterior lamina (AL), and lamina-batilliformis (LAB). It consists of two promient chitinous lateral bars (LB) which unite with each other at one end below the lamina-batilliformis, while on the other end the lateral bars are free, divergent and articulated with the posterior portion of the supporting framework (PPSF).

The anterior portion of the framework (APSF) supports the ante-

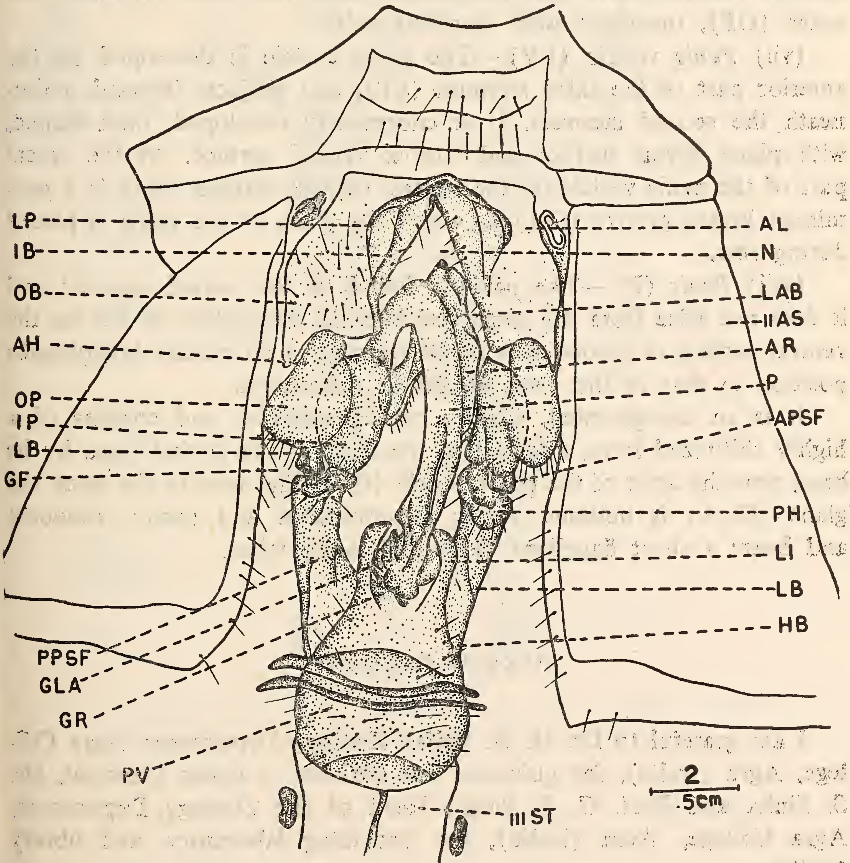

Fig. 2. Ventral view of the secondary copulatory complex with penis *in situ.*

rior lamina (AL), the lamina-batilliformis (LAB), the anterior pair of hamules (AH) and also the proximal part of the penis (P).

The posterior portion of the framework is very thick and well developed. It is somewhat U-shaped structure with two thick lateral bars (LB) and a horizontal bar (HB), lying below the anterior portion of the penis vesicle (PV). The posterior portion of the supporting framework (PPSF) supports the anterior portion of the supporting framework (APSF), posterior pair of hamules (PH), the apical portion of the penis vesicle (PV), together with the distal part of the penis (P).

(vi) *Hamules* (AH & PH).—The hamules are chitinous and robust structures, situated behind the anterior lamina (AL) and articulated with the framework. There are two pairs of hamules. The anterior pair of hamules (AH) are well developed while the posterior pair of hamules (PH) are reduced to papillae and situated at the junction of the anterior and posterior portions of the supporting framework. The anterior hamules have four prominent plates, two inner (IP) and two outer (OP), furnished with marginal hairs.

(vii) *Penis vesicle* (PV).—The penis vesicle is developed on the anterior part of the third sternum (ST), and projects forward underneath the second sternum. It is enormously developed, flask-shaped, with plane dorsal surface and convex ventral surface. At the apical part of the penis vesicle on the ventral convex surface, there is a prominent lipped groove (GR) in which the glans of the penis is placed during rest.

(viii) *Penis* (P).—The penis is found on the second segment and it does not arise from the penis vesicle as in Anisoptera. It lies on the ventral surface of second abdominal segment in an exactly homologous position to that of the penis sheath in Anisoptera.

It is an unsegmented, slightly curved structure and consists of a highly chitinized stem, attached to the floor of the genital fossa by its base, near the apex of the penis vesicle (PV). The apex of the stem, the glans (GLA) is bulbous, partly membraneous and partly chitinous; and bears a short flagellum (FL) and many lobes.

ACKNOWLEDGEMENTS

I am grateful to Dr. H. N. Baijal, Zoology Department, Agra College, Agra (India), for guidance and criticism. I thank Principal, Dr. S. Sinha and Prof. C. P. Singh, Head of the Zoology Department, Agra College, Agra (India), for providing laboratory and library facilities.

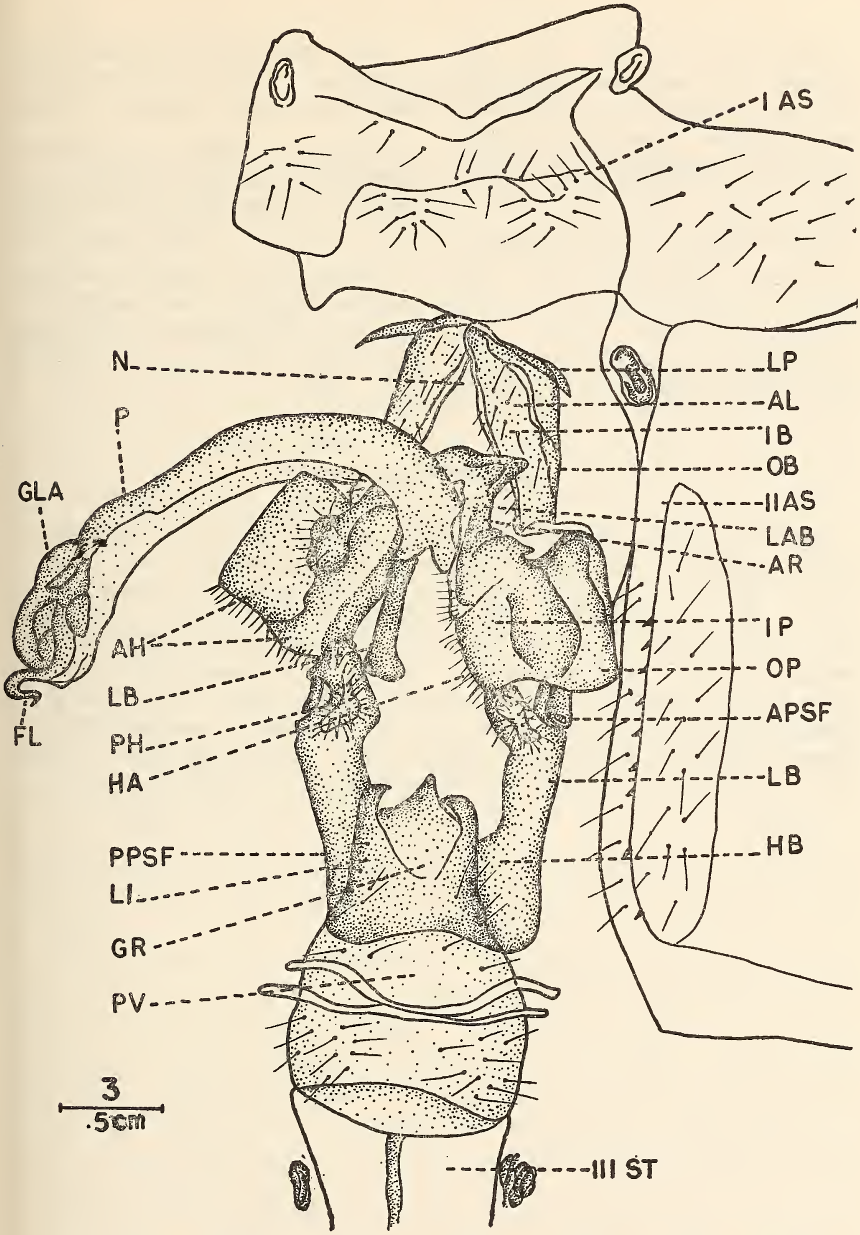
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Fig. 3. Venetral view of the secondary copulatory complex with penis, displaced from its natural position.

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ABBREVIATIONS

AGP — Anterior genital plate; AH — Anterior hamule; AL — Anterior Lamina; APSF — Anterior portion of supporting framework; AR — Arm; C — Coxite; FL — Flagellum; GF — Genital fossa; GLA — Glans; GR — Groove; HA — Hair; HB — Horizontal bar; IAA — Infra-anal appendages; IB — Inner border; IP — Inner plate; LA — Lamina analis; LAB — Lamina-batilliformis; LB — Lateral bar; LI — Lip; LP — Laminar process; MGP — Male gonopore; N — Notch; OB — Outer border; OP — Outer plate; P — Penis; PGP — Posterior genital plate; PH — Posterior hamule; PPSF — Posterior portion of supporting framework; PV — Penis vesicle; SAA — Supra-anal appendage; SP — Spine; ST — Sternum; VP — Vestigial penis.

Reviews

1. ECOLOGICAL PRINCIPLES FOR ECONOMIC DEVELOPMENT. By Raymond F. Dasmann, John P. Milton and Peter H. Freeman. pp. viii + 252 (23 × 15 cm), with 31 text-figures. London, 1973. John Wiley & Sons Ltd. Price?

One of the cherished projects of the International Union for Conservation of Nature and Natural Resources had been to produce a book that would draw the attention of planners of developing countries to the mistakes of the over-developed West and to point out that there was no purely technological solution available to solve the problems of the human race. Oxygen must still be produced by green plants and for the conservation of much needed freshwater a whole range of natural factors must be taken account of. Almost any development which man undertakes today impinges on the natural ecosystem and to ensure that economic planning is undertaken in such a manner that nature is not forced to hit back and undermine these developments is the purpose of this book.

Apart from analysing the general ecological considerations of which planners should take note there are valuable guidelines for the development of humid tropical lands, pastoral lands of semi-arid regions, tourism, agriculture and river basin development.

The rate at which deforestation is going on in India, a matter of serious concern for our country, the following statement in the chapter on River Basin Development Projects is of great relevance to our country:

Any change in the watershed area will affect the flow of water and quantity of sediment carried downstream. The protective role of forests in maintaining a relatively stable flow of water for reservoir impoundments and irrigation works is well established. Not only does protective vegetation decrease flood peaks, but it also usually increases water discharge during dry periods. Forests and their root systems are also of great importance in preventing erosion and reducing sediment loads in streams and rivers.

It is also significant that the water hyacinth which has become such a menace in our country by interfering with navigation, fish cultivation, etc. should also be responsible for so much loss of water through evapotranspiration. According to the authors 'in the dry atmosphere of India the loss of water through water hyacinth was 7-8 times that of open water'. Obviously there is need for widespread research to find some biological controls against the spread of this exotic water plant. It has been suggested that the manatee (*Trichechus* sp.), a herbivorous freshwater mammal inhabiting parts of Africa and Latin America and consumes large quantities of aquatic plant material may be one possible control species.

Z. F.

2. A FIRST GUIDE TO THE INDIAN OCEAN SEASHORE.

By F. M. J. Pinn. pp. 72 (19.5 × 14 cm), with many illustrations. Nairobi, 1973. Oxford University Press. Price Rs. 11.00.

From the rather bombastic, too-inclusive title of this booklet, accompanied by a very professional appearance of the colour photograph of the head and fore-body of a hermit crab on the cover, the reader would be led to believe that it is a taxonomic account of the intertidal animals from several countries bordering the Indian Ocean. It is only when one browses through the first few pages and looks at the amateurish sketches, or cares to read the matter on the back cover, that he gets a true idea—that the booklet is meant for schoolchildren. If that was its intention it is a fair performance, but it should have been so labelled.

The title is unfortunate in another respect, too. It would lead the reader to believe that the animals treated in the booklet come from all over, or at least from a fairly wide and representative coverage of regions of the Indian Ocean. In reality the author would have covered only a few of the East African beaches. It is fortunate for him that many of the animals described therein enjoy a cosmopolitan distribution, thus giving some support to his claim. It is for this reason that the booklet might also appeal to readers from other tropical countries.

The text is clearly written and free of the coy overtones that often ruin books intended for children. The illustrations, however, are shoddy. Those of sea-shells are tolerable, but one would be hard pressed to restrain a smile when he looks at the almost droll fish which is being squirted by the cuttlefish on page 46, or the inflated porcupine fish on page 68. And, after looking at the crab with one claw and both eyes missing (on page 20), the other crab (on page 22) with bent eyes, only four legs, and rectangular mouth, or the rosebud-like goose barnacles on page 26, one wonders how it is claimed (on the outer cover) that the "superbly accurate and detailed" drawings "will greatly help in the precise identification of the fish, shells and coral. . . ." The drawings, in the reviewer's opinion, are too poor and impressionistic and are ill--suited to be helpful to even the amateur naturalist, let alone to the serious student of animal classification.

The Table showing tide times and heights (on page 10) is superfluous in a booklet meant for children, and would better have been left out.

The appropriateness of the booklet is best left to the young reader to judge. If it effectively does what it is intended to do—namely, stimulate interest for seashore life, it will be the kind of book that makes an attractive present for the youngster beginning to take an interest in marine biology.

B.F.C.

3. A REVISED HANDBOOK TO THE FLORA OF CEYLON. Edited by B. A. Abeywickrama, Volume 1 (Part 1). pp. ii + 109 (24.5 × 16.5 cm), with 11 figures. Sri Lanka, 1973. University of Sri Lanka. Available from Smithsonian Institution Press, Washington, D.C. 20560, USA. Price $4.50 (Sterling £ 1.90).

Continuing advances in plant taxonomy call for revision of most works on the plants of tropical Asia. A combined effort on the part of the University of Sri Lanka, the Department of Agriculture of Sri Lanka, and the Smithsonian Institute (Washington, D.C., USA) has resulted in the beginning of a revision of Trimen's *Handbook of the Flora of Ceylon,* published from 1893-1901 with a supplement by Alston in 1931, a work long out of print. The first part presents nine angiospermous families: Apocynaceae, Asclepiadaceae, and Periplocaceae by H. Hueber (Botanisches Institute II, Wuerzburg, Germany), Loranthaceae and Viscaceae by D. Wiens (University of Utah, Salt Lake City, Utah, USA), Bignoniaceae by W. Theobald (Occidental College, Los Angeles, California, USA), Pedaliaceae, Gesneriaceae, and Martyniaceae by W. Theobald and D. Grupe (Occidental College, Los Angeles, California, USA).

This work has a number of fundamental strengths. It is based on careful restudy of the original Singhalese collections made and studied by Trimen which fortunately have been preserved in Peradeniya. The revision is also based on unusually ample modern collections being made in Ceylon. Finally, whenever possible, there has been an effort to recruit specialists and to send them in the field where they can study the populations at first hand. All of this adds greatly to the value of the work. Drs. Abeywickrama and Fosberg and their supporters have rendered a genuine service by initiating this happy and hopefully serendipitous venture.

It should be noted that the title word "Handbook", with its concept of something that fits the hand, was misapplied to the original edition by Trimen. That edition came out in five parts (volumes) and totalled 2,044 pages. The "Revised Handbook" promises to be even larger since the nine families published use 109 pages and only required 73 pages in the original edition. A rather small type face (6 point) is much used in the revision. Thus, the revision is substantially enlarged.

Not all family treatments are of the same scope. Dr. Hueber's treatment include synopses of suprageneric taxa, citation of place of publication of generic names, generic synonymy, type species of genera, chromosome numbers, and uses of plants. Dr. Theobald omits some of these features but includes illustrations. Dr. Wiens omitted these extras. Users of this work will be grateful that the editors have decided to include such valuable information when it has been submitted by an author, rather than eliminating it for the sake of consistency or expediency.

Only a few author errors could be detected. *Aganosma cymosum* (page 19) is incorrectly treated as neuter instead of feminine. *Tylophora tenuissima* (Roxb.) Wight (p. 44) was accepted instead of *Tylophora tenuis* Blume because Roxburgh's basionym, *Asclepias tenuissima,* was incorrectly attributed to the first edition of Roxburgh's *Flora Indica* (as "1821"). In fact, Roxburgh's basionym dates from the second edition (1832) and *Tylophora tenuis* Blume (1826-7) is the correct name, being priorable. The authorship of *Macrosolen* (p. 63) and *Tolypanthus* (p. 69) was attributed to "(Blume) Reichenb" [1841] when it should be attributed to "(Blume) Blume" [1830]. The specific epithet in *Dendrophthoe lonchiphyllus* (p. 66) uses an incorrect connecting vowel and the wrong gender and should be "*lonchophylla*". The binomial *Epithema carnosum* Bentham (1835) on page 103 is incorrectly treated as if it had *Aikinia carnosa* G. Don (1838) as a basionym, instead of the other way around. The citation in the same place of Bentham's publication of "Scroph. Ind. 57:665. 1835" is an error for "Scroph. Ind. 57. 1835."

These few and minor errors only emphasize the extremely high standards of this work. Anyone dealing with tropical plants, particularly those of tropical Asia, will need this work. The first part is the beginning of a promising series that will have a major impact on botany in this part of the world.

D.H.N.
C.J.S.

4. TROPICAL AQUARIA. By G. E. Williams. pp. 48 (18 × 12 cm). Second Edition. Horniman Museum & Library, London, 1973. Published by the London Education Authority.

The growing interest of the general public in fish-keeping at home has prompted an increasing number of popular books on this subject. In the present one, the author has done the fish-oriented a favour in bringing together in popular treatment the dos and don'ts of the hobby. The book is basically a how-to-do-it and is directed to the beginner aquarist.

The starting "chapters", each of two to four pages, deal with the construction and setting up of aquarium tanks, and their lighting and heating. That on circulation takes up more space but deals mostly with the systems used at the Horniman Museum. A list of the most interesting plants and fishes, with minimal description, comprises what would be the main chapters in books of this type. Hints on feeding, and on diagnosing and treating six common fish diseases make up the rest of the book, being contained in two "chapters", totalling less than eight pages.

The book is written with considerably more accuracy than most of the current flood of popular books in this hobby. Although written by a scientist, it is devoid of scientific jargon, and its explicit style shows how a technical subject matter can be written without using fancy language. However, the book suffers considerably from its extreme condensation. Readers should not, therefore, expect much more than bare service from this overcrowded little book with its compact arrangement.

The arrangement of the book, appropriately, appears to have been determined as much by questions put to the author in the course of his official duties as by the subject itself.

The few illustrations that are neat and simple, but deal only with technicalities. Apart from two electric circuit diagrams and two water-circulation devices, the only other pictures are those of six fishes on the cover. More illustrations of popular fishes, aquarium plants, and common live foods would have been appreciated.

Although the author claims that one of the aims of the handbook is to give a description of some of the fish exhibits in the Museum, his chapter "The Fish" is more on the lines of such chapters is most hobby books. For example, for most of the fishes he has given colour descriptions. These are not at all useful to visitors to the Museum, as, anyway, they would be seeing these colours on the bodies of the fishes. He could have avoided this and, instead, devoted more space to describing peculiar habits, etc.

For the beautiful glossy cover and neat printing on good quality paper, the price of the handbook, at 15 p. is surprisingly low.

Except for the principal shortcoming, *viz.* lack of detailed treatment of the subjects covered therein, it is a good elementary handbook—hobbyists wishing to learn more will find the list of books and periodicals on the last page very handy.

B.F.C.

5. CLASSIFICATION OF THE ANIMAL KINGDOM — An Illustrated Guide. pp. 55 (31 × 23.5 cm), with many illustrations. London, 1972. The Universities Press Ltd. and the Reader's Digest Association Ltd. Price £1.35 net in U.K.

This book first appeared as a section *The Living World of Animals* published by the Reader's Digest Association Ltd. and is now available in a separate edition for the use of students.

The introduction by Richard Freeman, a reader in zoology at the University College, London, discusses in not too difficult terms the need for and systems of classification. When studying an animal, the morphological, physiological, behavioural and genetic characteristics are all considered and these are compared with similar sets of characteristics relating to another. In this way, relationships are established and the hierarchy of groups in classification is determined.

The contributions of Francis Willughby (who, in 1676, published a work on all the species of birds then known) and Linnaeus who provided the starting point for all generic and specific names for animals, are described in some detail and Freeman points out some odd results that arose out of Linnaeus's system of classification — for instance, the Swedish zoologist divided mammals into orders on their dentition, resulting in a bracketing of rhinos with mice!

Inevitably, some groups have been treated in greater detail than others, but no phylum has been omitted. All terrestrial vertebrates—as these are the groups that observations of nature and field workers are most likely to encounter — have been taken down as far as families, with brief notes on appearance and habits and examples that are illustrated. The very large number of families among insects and fishes and the technical language involved, Freeman points out, precluded their treatment in the same detail.

A useful book with excellent illustrations and not too involved. Perhaps it is a failing that it is so simple, for the student will quickly outgrow it.

NEELA D'SOUZA

Miscellaneous Notes

1. STATUS OF THE TIGER IN BURMA

In WILD LIFE SANCTUARIES by Kyaw Gyi, Sarpay Brikman of the Printing and Publishing Corporation 1973, the author states that according to Forest Department's estimate there were 1621 tigers in Burma in 1962.

Outside Reserves	1195
Inside Reserves	426
	1621

The total land area of Burma is 261227 square miles. The area under forests in known to be 149783 square miles or 57 per cent of the total land area in the Union. The area under Reserved Forests is 34068 square miles or 13 per cent of the total land area in the Union.

J. D. Bitkinson 1948 (Forests and Forestry in Burma. *Jour. Roy. Soc. Arts*, London *96*:478-491) states that Burma has almost the same area of actual forest as India.

The author of WILD LIFE SANCTUARIES is a retired Chief Conservator of Forests, Burma.

25, INYA MYAING ROAD,
UNIVERSITY P.O.,
RANGOON, BURMA,
September 17, 1973.

TUN YIN

2. WEIGHT AND SIZE AT BIRTH OF TWO SPECIES OF WILD MAMMALS IN CAPTIVITY

This note deals with the weight and size at birth of two species of wild mammals observed at Nandankanan Biological Park, Orissa. The weight and measurements were taken within twelve hours of birth.

Jungle Cat (*Felis chaus*)

The four kittens born in one litter on 17.1.1973 weighed from 103 to 126 gm with an average of 111.25 gm and measured from 22 to 24 cm with an average of 22.5 cm from nose tip to tail tip including 6 cm to 7 cm (average 6.5 cm) long tail at birth.

In available literature, there appears to be no report on weight and size of this cat at birth.

Indian Wild Boar (*Sus scrofa cristatus*)

The seven piglets (one out of 4 born in one litter on 10.viii.'72 and 6 born in one litter on 23.ix.1972) weighed from 325 to 665 gm with an average of 557.43 gm and measured from 31.5 to 37 cm with an average of 35 cm from nose tip to tail tip including 4.5 cm to 6 cm (average 5.36 cm) long tail. The shoulder heights were from 14 to 16.5 cm with an average of 15.36 cm. The one young which weighed 325 gm and measured 31.5 cm could not stand without support as it was very weak at birth.

The literature available to us has no report on this subject.

VETERINARY ASST. SURGEON, L. N. ACHARJYO
NANDANKANAN BIOLOGICAL PARK,
P.O. BARANG, DIST: CUTTACK.

WILD LIFE CONSERVATION OFFICER, R. MISRA
OLD SECRETARIATE BUILDING,
CUTTACK-1 (ORISSA),
February 21, 1973.

3. BURROWING HABITS OF THE GREATER BANDICOOT RAT (*BANDICOTA INDICA*)

(*With a text-figure*)

INTRODUCTION

The Greater Bandicoot Rat is one of our largest rodents, weighing on an average more than one kilogram. It is a confirmed commensal of man, always living in close vicinity of human dwellings and feeding on refuse and storage products. The Greater Bandicoot Rat is not conspicuous for its large burrows which cause considerable damage to huts and godowns. Practically nothing is known of the biology of this animal in spite of its being one of most serious rodent pests of India. The present note is an account of its burrowing habits.

MATERIALS AND METHODS

This account is based on an investigation of the structure of eighty-three bandicoot burrows. All the burrows under study were currently or very recently occupied as evidenced by the presence of soil produced by fresh diggings and sighting of the bandicoot rats by local inhabitants. The study involved a careful excavation of each burrow, noting down their dimensions and any contents. The excavations were carried out at three times of the year: 30 burrows during the second week of October 1972, 23 burrows during the fourth week of February 1973, and 30 burrows during the fourth week of July 1973. All the burrows were located in the vicinity of the Chatushringi hill in Poona.

RESULTS AND DISCUSSION

The burrow is a winding tunnel roughly circular in cross-section, its diameter ranging from 8 to 15 cm. The tunnel is of a fairly constant diameter throughout, and does not enlarge into any chamber-like spaces. The tunnel makes a number of twists and turns under the ground and may lead to several blind alleys. The total length of the burrows excavated ranged from 44 to 520 cm. The maximum depth of the burrows ranged from 23 to 115 cm. A single burrow may open above ground by one to four separate openings. Fig. 1 is a sketch of one of the burrows and Table 1 provides more detailed statistics on the dimensions of the burrows.

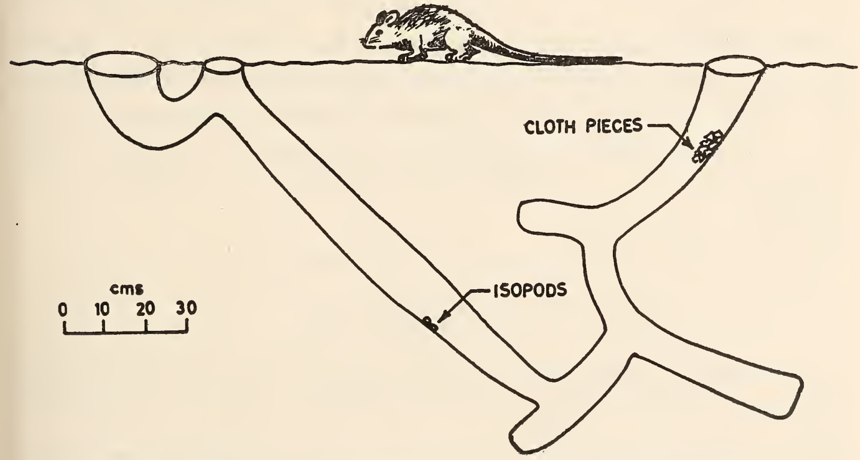

Fig. 1. Sketch of a burrow of the Greater Bandicoot Rat.

None of the excavated burrows were found to harbour any stored food materials. Many but not all of the burrows contained accumulations of cloth and paper pieces, particularly at the end of a blind alley or near a turning in the tunnel. We found a number of commensals in many of the burrows; these included isopods, spiders, centipedes, beetles and lizards. As we have covered a number of burrows in all the major seasons of the year, we may safely conclude that the burrow does not serve for food storage, but as a shelter for the Greater Bandicoot Rat.

TABLE I
CHARACTERISTICS OF THE BURROWS OF *Bandicota indica*

No. of openings	1	2	3	4
No. of burrows	40	28	13	2
Total length of tunnel (cm)	51-100	101-200	201-300	301 or greater
No. of burrows	20	42	17	4
Depth of tunnel (cm)	upto 50	51-70	71-90	91-110
No. of burrows	26	27	23	7

Bandicoot burrows were found to be organized into colonies of 2 to 15 burrows. Distances between openings of neighbouring burrows in a colony ranged from 20 to 700 cm, the average separation being about 100 cm. The colonies are always next to a house or a grain storage godown generally lying at the back of the houses close to a fence or compound wall. The burrows often extend under the floor of the house and occasional burrow openings are produced inside the house especially if it has a mud flooring. The burrows within each colony are fairly compactly aligned next to each other and each colony is a clearly discrete entity. One colony may be separated from an adjacent colony by several hundred metres. Whether such colonies constitute a genuine deme will depend on the extent of migration of individuals from colony to colony. No data are as yet available on this problem.

ACKNOWLEDGEMENT

We wish to acknowledge the kind support of Dr. G. B. Deodikar, Director, M.A.C.S., Poona.

BIOLOGY DEPARTMENT,
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A. V. ARJUNWADKAR

MAHARASHTRA ASSOCIATION FOR THE
CULTIVATION OF SCIENCE,
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MADHAV GADGIL[1]

September 11, 1973.

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4. STORKS PREYING ON LIVE BIRDS

In 1969, I had been informed by Shri V. S. Saxena the then Divisional Forest Officer, Bharatpur, that Blacknecked Storks (*Xenorhynchus asiaticus*) capture and eat coot; one of our shikaris confirmed this, but I found it hard to believe.

In April 1973 during the fag end of our Bird Migration camp. I twice observed Blacknecked Storks hunting down diving coot in shallow water which they captured and swallowed whole. On a third occasion another stork of the same species snapped up a flying coot out of a group it flushed while skimming over the water.

At the same period Adjutant Storks (*Leptoptilos dubius*) and Blacknecked Storks were seen walking down flightless injured ducks which could not dive away in the foot or two of water remaining. The victims were invariably snapped up by the neck, and shaken till dead and swallowed whole.

BNHS BIRD MIGRATION CAMP, JAMSHED D. PANDAY
BHARATPUR,
RAJASTHAN,
December 10, 1973.

5. BREEDING OF THE LESSER FLAMINGO, *PHOENICONAIAS MINOR* (GEOFFROY) IN KUTCH

(*With two photographs*)

In 1945 I wrote in THE BIRDS OF KUTCH: "Lester's (1903) presumption that it [Lesser Flamingo] breeds in Kutch has not been confirmed. So far it is not known to breed within Indian limits at all." Later (1954), in my paper on the birds of Gujarat (*JBNHS 52*:384) I recorded as follows: "Between 25 February and 2 March 1946, enormous concentrations roughly estimated as close on a hundred thousand birds [! ?] with no admixture of *ruber*, were observed on the flat muddy expanse of the shallow Banas River near its mouth (opposite Dhutari Bet) in the Little Rann of Kutch. The species has so far not been found breeding within Indian limits, but there seems high probability of its doing so in the Great or Little Rann. The gathering here included numerous birds in the brown postjuvenal plumage, perhaps not more than 2 or 3 months old, which could well be from this undiscovered breeding ground." Sustained enquiry in the intervening years of likely persons living in Kutch and visitors to the suspect areas had failed to elicit any positive evidence, and the question of whether, and where, the Lesser Flamingo breeds in the Rann remained baffling.

It is thus of particular interest to record that on a recent visit to 'Flamingo City' off Nir in the Great Rann (January 24, 1974) with Shri Shivrajkumar Khachar of Jasdan and Shri Ramsinhji Rathod, DFO Kutch, we were finally rewarded with firsthand proof of the species breeding within Indian limits. Water conditions in the Rann and logistics of our expedition to the colony were more or less identical with those recorded in my note "Flamingo City re-visited" in March 1960 (*JBNHS 57*:413-15) and need not be recounted. After the heavy monsoon inundation the edge of the Rann was still wet and boggy and impassable for jeeps, so—as on the previous occasion—we motored from Khavda to Kuran (*c.* 15 km) and then transferred to camel-back. The route to Nir lay along the stony base of the Kala Dongar hills across rocky hummocks and dry stony water courses, sparsely scattered with *Euphorbia, Salvadora, Zizyphus* and *Prosopis* scrub. The distance from Kuran to Nir, said to be *c.* 22 km, took 4½ hours of merciless pounding in some of the most uncomfortable saddles ever designed! The distance from our bivouac at Nir to Flamingo City, approximately 10 km, was covered on the same mounts in 2½ hours next morning, over alarmingly slithery slush alternating with shallow brine and stretches of billiard-table flat dry compacted sand. Owing to abnormally heavy monsoon rains in northwestern Gujarat in the 1973 season, the Great Rann had been deeply inundated by the Luni River and the water level in the Flamingo City area apparently did not become favourable for nesting till late October or early November. Dr. Philip Kahl, who is making a comparative study of all the flamingo species of the world, flew over the breeding ground on 15 November and took the accompanying aerial photographs to support his visual estimate of 10,000 nests in the two sectors of the City. On these he was able to count 7132 nests in occupation. The majority of birds were apparently the larger species, and he found no indication that the few Lesser Flamingos present among them were engaged in any breeding activity. As the nesting had apparently begun only a short while before, Dr. Kahl felt that the numbers would increase as water conditions improved, and he suggested our visiting the place a couple of months later to check the position.

As our camelcade neared the 'City' the sight, as usual, grew increasingly breath-taking. The muffled 'roar' of the birds in the distance sounded exceedingly like the continuous grind of some mighty electric generator in action. Through binocular could be marked down on the horizon at least three other separate, fairly large, breeding colonies between the traditional Flamingo City and Bhanjda Bet, towards the east and south. I have no recollection of these colonies from my previous visits, and it may be that they are new extensions. They were too far to give any idea of size, but seemed well populated. Flamingo City itself

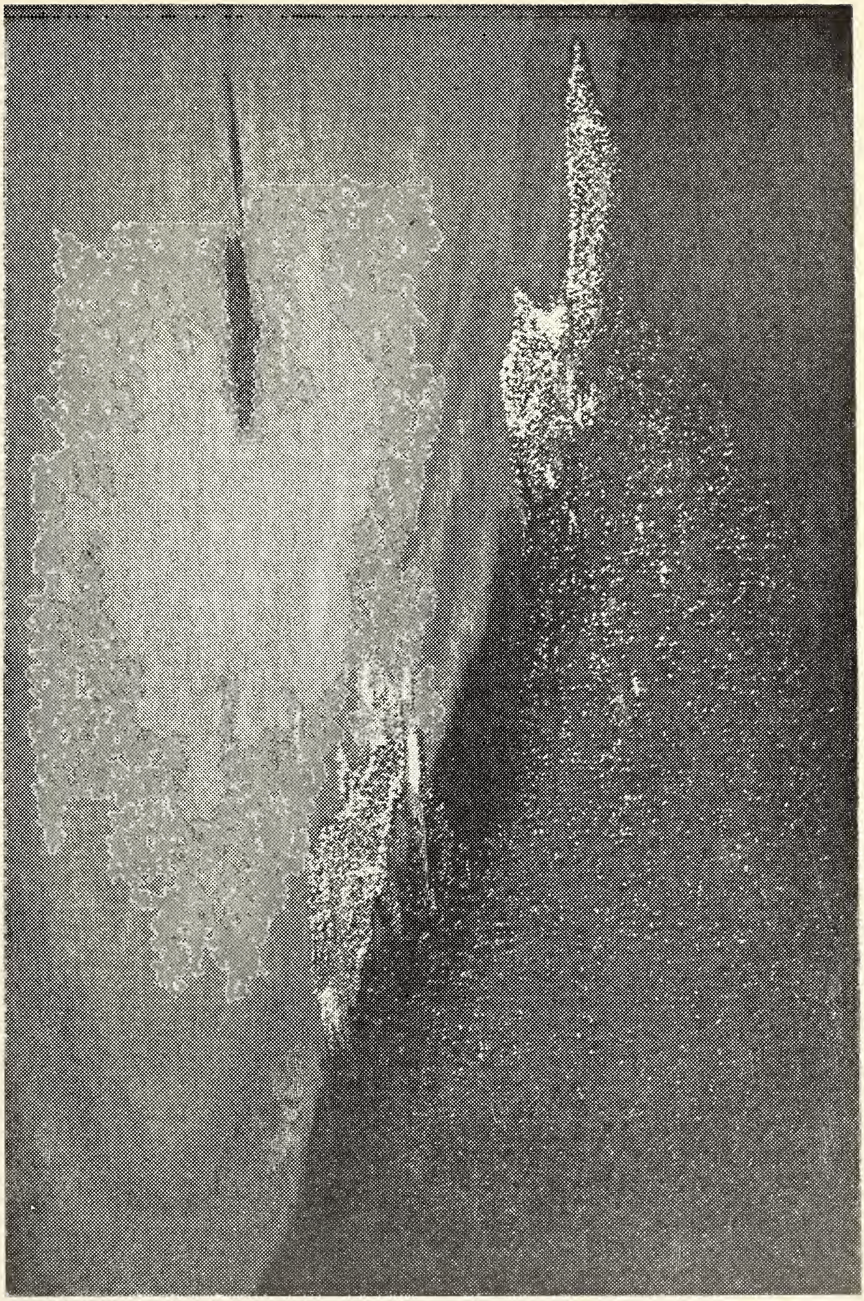


Photo 1. Flamingo colony — Great Rann of Kutch — 15 Nov. 1973,
(photographed from the NE).
(*Photo*: *M. P. Kahl*)

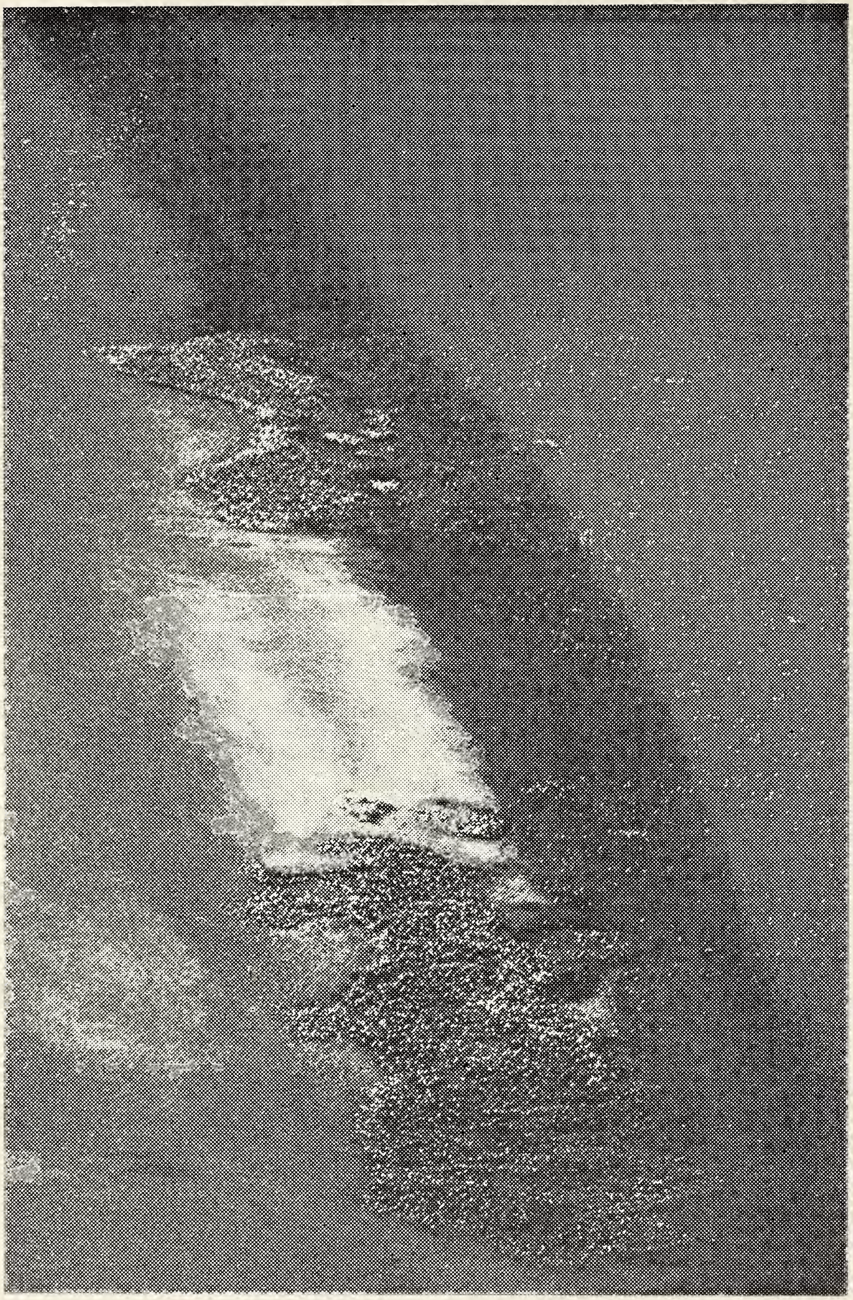


Photo 2. Flamingo colony — Great Rann of Kutch — 15 Nov. 1973, (photographed from the S).

Counts from photo show approx. 4856 nests in "south colony" (nearest camera) & 2272 nests in "north colony" (top of photo), for a total of approx. 7132 nests.

(*Photo*: *M. P. Kahl*)

appeared to be in two major sectors connected by a rather sparsely populated "neck". I have grown sceptical of visual estimates of numbers, including my own—specially when made from ground level. But for what it is worth, it may be mentioned that among the enormous number of birds present (estimated as 25 to 30,000) we guessed the total number of Lesser Flamingo in the more congested sector of the mixed colony ("north colony", photo 2) to be between 2000 (SA) and 5000 (Shivrajkumar). The nests, with these birds sitting on eggs or newly hatched chicks, were scattered among those of the Larger, but some sections were patronized almost exclusively by *P. minor*. These segregated *mohallas* or 'ghettos' stood out clearly in the distance as patches of dark rosy pink against the white masses of *roseus*. Nearly all nests of both species contained eggs in every stage of development —mostly hard-set or chipping or just hatched—in addition to a great many newly hatched chicks in french grey velvety powder-puff down, and hordes of older grey plumaged runners (pullets) of more or less uniform size, between *c*. 30 and 60 cm tall (estimated as 30-40 days old), looking like a vast stretch of mobile undergrowth around the parents' legs while being herded away at our instrusion. No significant difference was apparent between the architecture of the nests or colour and egg-size of the two species, though my impression is that eggs of *minor* were somewhat less narrow and elongate. No marked difference was noticeable in the newly hatched chicks either, except that those of *minor* were perhaps of a slightly browner grey velvet. In fact the two were not recognizable apart, and the nests of *minor* had to be carefully marked down from a distance for closer examination. There were one or two small unoccupied satellite colonies in the 'suburbs', separated from the 'metropolis' by 200 metres or so of dry flat ground —which had probably got left high and dry by the receding water line before they could be fully occupied (top right, photo 1). Although some of these nests looked freshly made there was little evidence of their having been used, except some of them possibly by the earliest breeders of the season. A vast area—perhaps a square kilometre or more—on the leeward side of the City was littered fairly evenly with individual wind-scattered white feathers which, in the lengthening shadows of the setting sun, looked curiosuly like glistening snow flakes or the aftermath of a hail storm.

That *P. minor* was breeding in Flamingo City in such large numbers this year when none were found doing so on my previous visits, may possibly be due to some hydrologic disturbance caused by the throwing of the bund across the Little Rann (Banas River outflow) for the National Highway to Kandla in the southern section, forcing the birds to transfer their (suspected) breeding ground to the Great Rann. It will be interesting to watch whether the birds will breed regularly in Flamingo City hereafter.

It will be remembered that the first records of the breeding within Indian limits of the Avocet and Rosy Pelican were also obtained fortuitously during flying visits to Flamingo City in 1945 and 1960 respectively (*JBNHS 45*:420-21; *57*:413-15). The present discovery of Lesser Flamingo breeding further highlights the potentiality of the Great Rann as a repository of ornithological, and doubtless other, surprises, and emphasizes the desirability of a properly planned biological survey of the entire area.

46 Pali Hill,
Bandra,
Bombay 400 050,
March 19, 1974.

SALIM ALI

6. NOTES ON A SOOTY TERN (*STERNA FUSCATA NUBILOSA* SPARRMAN) COLLECTED NEAR CALICUT

In the first week of June this year a female Sooty Tern was brought to Professor K. J. Joseph of the Zoology Department, Calicut University by a person who had trapped it near the campus. It was an adult bird with very worn and moulting flight feathers. Presumably, it had finished breeding and was blown inland from the coastal area. The campus is about 7 miles distant from the coast of the Arabian Sea and in June we had many strong gales.

This species breeds in the Lakshadweep from December/January to May [Salim Ali and Dillon Ripley, 1969, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN Vol. 3:63]. In the specimen examined moult of the feathers of the body had been completed, but the flight feathers (both remiges and rectrices) were still moulting. It measured: wing 297 mm; outer tail feathers 147 mm; bill 39 mm from feathers; tarsus 23 mm. Both wing and tail had broken tips. The ovary had regressed.

Primaries 2 to 8 (counting from the proximal end) had recently completed their growth. In the right wing the 8th primary was about three-fourths and in the left, one-fourth grown. In both wings primaries 9-10 were old. Alula were moulting. As some of the secondaries (including the feathers of the skin overlying the humerus) were missing, they could not be numbered exactly, but we could count 19 in one wing and twenty in the other. The colour, texture, and moult of the secondary feathers suggested that their moult had started at three different points. The outermost or first secondary was moulting in both wings, and the 14th in the left wing alone. In both wings, secondaries 2 to 13 were old and very much worn. The innermost group of

5-6 secondaries (or tertiaries) had apparently completed growth much earlier and were faded to some extent but strong. This suggested that the tertiaries had moulted at a different time.

The greater upper coverts of the remiges had either recently completed growth or were in the final stages of growth, so were the upper lesser wing-coverts and the upper tail-coverts. The upper median wing-coverts were old. All the body tracts of feathers had fresh feathers suggesting a recently completed moult.

The overall pattern of moult of flight feathers suggested a gradual exchange of flight feathers without impairing flight completely at any point. This is important for the survival of the bird as it spends most of its time in the air. Renewal of the upper greater wing-coverts in advance of the moult of remiges themselves, and completing the moult of the tertiaries earlier, are protective. Fully grown upper greater coverts protect the sensitive areas at the base of the growing wing quills; the tertiaries protect the rest of the wing quills in the folded wing.

SUBDIVISION OF ECOLOGY & ORNITHOLOGY,
ZOOLOGY DEPARTMENT,
CALICUT UNIVERSITY 673635,
June 9, 1973.

D. N. MATHEW
E. A. A. SHUKKUR

7. MORE CUCKOO PROBLEMS

In the nineteen-thirties the *Journal of the Bombay Natural History Society* had devoted a number of pages to "cuckoo problems" concerning the parasitic habits of this bird. The present note is intended to call attention to another "problem": the winter quarters of some cuckoos, especially the Common Cuckoo *Cuculus canorus*. It seems to be an accepted fact that some of the Cuckoo populations spend the winter in India. I have come to doubt this fact after checking the Indian literature and finding that we possess too few records between October and March to accept the assumption that India is a wintering ground for the Cuckoo; these records are: North Kanara, November and February (Davidson, *JBNHS 12*:51), Trivandrum, February (Ferguson, ibid. *15*:664), Maldive Islands, January (Philipps, ibid. *60*:579) and Andaman Islands, November, (Hume, *Stray Feathers 4*:288). The two known records from Sri Lanka are from October (one) and undated (one). The November records may well pertain to belated migrants. Vaurie (THE BIRDS OF THE PALAEARCTIC FAUNA, Non- Passeriformes 1965, p. 569) writes that the Cuckoo "winters in Africa... in small numbers in India, and in smaller numbers in the Indochinese countries." Even if we account for the fact that the cuckoo is unobtrusive and silent in winter, it would be very surprising that such an abundant, widespread and highly migratory species in the Palaearctic would pass almost un-noticed in southeast Asia. I therefore suspect that the main winter ground of the species including the Asiatic population is in Africa. It is the opinion of Moreau (THE PALAEARCTIC-AFRICAN BIRD MIGRATION SYSTEMS, 1972, p. 183) that probably a large proportion of the Asiatic birds winter in Africa. Unfortunately, the two subspecies presently recognized besides the nominate race are so poorly differentiated as to be of no value in determining the provenance of African winter guests.

Although it is usually stated that *Cuculus canorus* winters in southeastern Asia, it should be noticed that data for December to February are almost entirely lacking for the whole area. The winter status of this species for southeastern Asia including the Philippines, should probably better be changed to "straggler".

The Cuckoo appears to be abundant on passage in central India in September and October (Butler, *Stray Feathers* *5*:227, Barnes, *JBNHS* *4*:18, and others). Indeed the pattern of autumn migration in India is somewhat similar to that of the Redfooted Falcon *Falco vespertinus* which is known to winter in Africa. Whistler was similarly impressed by the lack of winter data for the Pied Crested Cuckoo *Clamator jacobinus* and also brought to attention the possibility that it might spend the winter in Africa (*JBNHS* *33*:136-145 and *37*:523). See also Wells, D. R., *JBNHS* *69*:179-185, for an amendment to the winter range of both *Cuculus saturatus* and *C. poliocephalus* given by Ali and Ripley in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN vol. *3*, 1969. The winter range of *C. canorus* will also have to be amended there.

Concerning the Emerald Cuckoo *Chalcites maculatus,* I have not found any definite winter records from India. Most observers in the Himalayan foothills refer to it as a summer visitor. In Assam, Hume (*Stray Feathers 11*:75) found it only in summer. The species is known to winter in the Malay peninsula and in southern Thailand but is a summer visitor in northern Thailand. In winter it reaches Sumatra and, probably at this season only, the Andaman and Nicobar Islands. The winter status of the Violet Cuckoo *Chalcites xanthorhynchus* in India is quite unknown.

U. S. NATIONAL MUSEUM, NHB 336, MICHEL DESFAYES
SMITHSONIAN INSTITUTE,
WASHINGTON, D. C. 20560,
March 22, 1974.

8. ON THE OCCURRENCE OF THE COMMON GREY HORNBILL *TOCKUS BIROSTRIS* (SCOPOLI) NEAR BOMBAY

The note on the occurrence of the Common Grey Hornbill *Tockus birostris* (Scopoli) in the Government House Gardens in Bombay City (S. R. Amladi & J. C. Daniel, *JBNHS 70*(2):378-379) prompts a few remarks.

I did record seeing a Malabar Grey Hornbill *T. griseus* (Latham) at Ghodbunder in Salsette Island on 17 April 1943. The bird was being chivvied by crows and the fleeting glimpse was put down as *griseus,* for this was the nearest recorded species (from the Ghat area of Khandala) and there was no evidence of *birostris* occurring in the Konkan, away from the Deccan.

In 1945, a bird flying across at Powai was definitely noted as *birostris* (*JBNHS 45,* p. 242) and many subsequent sightings more carefully examined convince me:

1) that the earlier records of *Tockus griseus* from Salsette and the Konkan were in error for *T. birostris,* and

2) that *birostris* has either newly entered this area or increased appreciably in numbers. Its occurrence in the neighbourhood of Bombay was not referred to by earlier authors but in recent years it has been seen on most trips to the Borivli National Park and also at Kihim, across the harbour in Kolaba district, where 8 were seen together. The birds in the Government House Gardens were mentioned to me a few years ago, but I did not have the opportunity of seeing them.

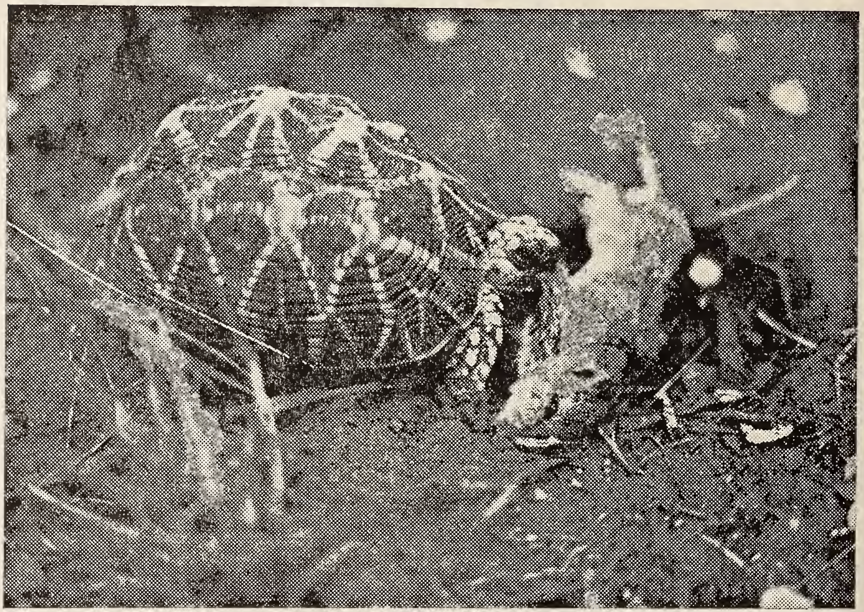
Having been specifically noted in April, May and December, it is unlikely that they are migratory to any large extent. The Grey Hornbill is essentially a bird of deciduous forests and open plains (or gardens) interspersed with large trees. I have seen it feeding on the fruit of the teak (*Tectona grandis*) and *Manilkara hexandra.*

75 Abdul Rehman Street, HUMAYUN ABDULALI
Bombay 400 003,
March 19, 1974.

9. FEEDING HABITS OF THE STAR TORTOISE—*GEOCHELONE ELEGANS*

(*With a photograph*)

In keeping several pairs of the land tortoise *G. elegans* we note that they are mostly vegetarians, feeding on a wide variety of grasses and shrubs which grow in our large snake enclosure. On several occasions we have noticed that the tortoises show an interest in dead rats which had been placed for the snakes. The tortoise has difficulty in breaking the tough rat skin but will consume the flesh of a rat's leg in about half an hour of pulling and "chewing". Pritchard in his LIVING TURTLES OF THE WORLD mentions that *G. elegans* is known to eat snails, but flesh eating by land tortoises seems a phenomenon and perhaps applies only to captive specimens deprived of a complete natural diet.



Geochelone elegans starts to feed on a dead rat.

MADRAS SNAKE PARK, R. WHITAKER
GUINDY DEER SANCTUARY,
MADRAS 600 022,
February 10, 1974.

10. BEHAVIOUR OF THE AGAMID GARDEN LIZARD, *CALOTES VERSICOLOR*

Only within the last few years, thermoregulation in tropical lizards has been investigated. The general conclusion is that selection of habitat, behaviour and thermal sensitivity are closely interrelated. The temperature is perhaps the most important limiting factor in the ecology of an ectotherm.

The object of this report is to study some aspects of observation on behaviour of the agamid garden lizard, *Calotes versicolor*.

Activity of the lizards: The activity of the *C. versicolor* was studied in great detail on a section of the Ravenshaw College campus area during the period June to December, 1971. The study involved not only behavioural studies but also counting of the population, sex-ratio observed on the plot at different times of the day. During this study no distinction with respect to size or stage of thermoregulatory behaviour was made but the conditions of temperature and light were noted.

Diurnal activity: *C. versicolor* is a diurnal lizard. The lizard starts activity in summer at about 6.00 a.m. and at about 7.00 a.m. during winter. Morning active phase may extend up to sunset with a short period of rest at noon. However, these active phases are dependent on factors like light and rain. During bright and warm weather most of them were found at rest under some shade in the field. During rain or stormy weather, lizards, took shelter on trunks of trees or in bushes. Observations of marked adults indicate that most of them were active throughout the morning when the weather conditions are normal and many remain in the bushes.

The lizards were found active in the morning hours when the sky was clear. Many of them left the bushes before 11.00 a.m. under 'cloudy' conditions of the sky, the lizards took longer time to reach their activity threshold and they were seen basking on the rock or stem till noon. The intensity of light in rock and stem shadow was found to vary from *c*. 100-400 and 75-375 ft. respectively.

Nocturnal activity: The adult and juvenile (S-V length range: 24-60 mm) of *C. versicolor* were observed to be inactive during nights irrespective of weather conditions. The lizards just rested or slept under the bush or on tree trunk or on branches of the tree.

Sleeping habits: The sleeping habits of adult lizards were observed. *C. versicolor* was observed to prefer the tree trunks and branches. They slept in a horizontal position, in such a habitat with their bellies touching the tree. During sleep, the legs of the garden lizard were folded close to the body and the tail was fully extended. The average height of the place to where they climbed and slept was 1.5 m (Range: 0.4-3.5 m). Sometimes, rarely both, adult males and females were observed sleeping close to each other irrespective of seasons at about 6.00 p.m. and they awoke at about 6.00 a.m.

Thermoregulation and temperature preferences: The adults and juveniles of *C. versicolor* were seen basking during sunshine. Mature adults were observed to spend more time for basking especially orientating their bodies to receive maximum sunshine. The basking range in *C. versicolor* is up to 35.0°C.

Since the basking behaviour was observed only during sunshine, it is considered to be related to the thermoregulation of the lizard. Furthermore, the activity of the lizard was found to be influenced mostly by the environmental temperature. The preferred temperature (is the mean of normal activity range) for the garden lizard, *C. versicolor* studied here fell around 36.0°C.

The body temperature in *C. versicolor* was higher than their habitat temperature (both air and substratum) during day time but almost same during night.

Thermal thresholds: The thermal thresholds (°C) in *C. versicolor* were observed as follows:–

1. Minimum voluntary tolerance: 24.0-27.5
2. Maximum voluntary tolerance: 38.1-40.0
3. Basking range: 27.6-35.0
4. Normal activity range: 35.1-38.0
5. Preferred temperature : 36.0
6. Critical thermal maximum: 45.0
7. Lethal temperature: 45.5

Moulting behaviour: *C. versicolor* moults frequently, starting with the head and finally the posterior region. During moulting the colour of the lizards was dark brown. The moulting takes place from 3 to 10 days.

ACKNOWLEDGEMENTS

Thanks are due to: Dr. R. Mohanty, Vice-Chancellor, Utkal University for permission to study the lizards in his garden; Prof. B. K. Behura, Head of the Department of Zoology for laboratory facilities and the Secretary, U.G.C. for financial support.

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November 30, 1973.

11. COBRA WITH KINGFISHER CAUGHT IN THROAT

Recently a cobra (*Naja n. naja*) was brought to us alive with the head and bill of a white-breasted kingfisher (*Halcyon smyrensis*) caught in its throat. The long beak and broad head of the bird was too much for the cobra to swallow or regurgitate and the snake would probably have died if we hadn't carefully removed the bird.

There are few records of cobras swallowing large, active birds. This adult kingfisher was perhaps caught by the cobra on its roost at night.

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February 10, 1974.

12. ALGAL FOOD OF *APLOCHEILUS BLOCHII* (ARNOLD)

Aplocheilus blochii (Arnold) is a small fish found in the streams of Nagpur. The fish is used as food by the poor. Microscopical study of the intestinal contents of the fish from their natural habitats showed the species of *Oscillatoria, Spirogyra, Cosmarium* and a number of diatoms.

It is known that the study of intestinal contents only do not give a correct idea of the food (Kamat 1966, 1969) and so a number of algae belonging to Chlorophyceae, Euglenophyceae and Cyanophyceae were tried to find out the algae used as food by the author's method (Kamat, loc. cit.).

It was found that species of *Oscillatoria, Anabaenopsis* (veg.), *Euglena* and diatoms are digested by the fish; species of *Spirogyra* and *Closterium* are partially digested while species of *Cosmarium, Oedogonium, Rhizoclonium, Chlorella, Scenedesmus, Pediastrum, Pandorina, Elakatothrix, Trachelomonas, Chroococcus, Microcystis, Merismopedia, Gloeothece, Lyngbya, Aulosira* and *Scytonema* are not digested at all. These algae when separated and cleaned from the excreta were found to be unaffected and could be grown in cultures. It may be mentioned here that *Pandorina* colonies when freed from excreta started swimming immediately.

The fish even when starved, did not take species of *Pithophora, Cladophora, Dichotomosiphon, Nitella, Lychnothamnus* and *Chara,* probably because they were too big.

One to four days old fry was found to grow much better on species of *Oscillatoria* alone than on a mixture of *Oscillatoria, Euglena* and diatoms. When a number of algae are given as food, the fish shows first preference for *Oscillatoria.*

Twenty five medium and large sized fishes were kept in a small cistern (3′ × 3′ × 3′) containing species of *Oscillatoria, Euglena* and *Cladophora* with epiphytic diatoms and after three years their number rose to 832.

ACKNOWLEDGEMENTS

I take this opportunity to thank Shri M. G. Radke of the Fisheries Dept., Nagpur for kindly identifying the fish.

BOTANY DEPT.,
INSTITUTE OF SCIENCE,
NAGPUR 1,
October 28, 1971.

N. D. KAMAT

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13. ON A NEW RECORD OF A MURREL, *CHANNA LEUCOPUNCTATUS* (SYKES) FROM RAJASTHAN

While collecting in lake Kailana (*c*. 13 km N. W. of Jodhpur, Rajasthan) a floating dead specimen of *Channa leucopunctatus,* measuring 647 mm in total length was collected. Subsequently, a fresh specimen of this species, measuring 560 mm in total length was collected from the same lake. Freshly caught specimens of this species have also been found in the local fish market. However, the occurrence of this species in Rajasthan is reported here for the first time.

Four species of *Channa,* namely, *C. punctatus* (Bloch), *C. marulius* (Hamilton), *C. striatus* (Bloch) and *C. gachua* (Hamilton) are reported earlier from Rajasthan (Datta & Majumdar 1970). Of these only *C. punctatus* and *C. marulius* have been recorded earlier from lake Kailana (Menon & Krishna 1958). I have also collected *C. punctatus* and *C. marulius* along with *C. leucopunctatus* from this lake.

Day (1889) gives the distribution of *C. leucopunctatus* as Coromandel and Western coasts of India, some of the rivers in the Deccan and Cauvery in Mysore, it is also said to be found in China. The present find, therefore, extends the known range of distribution of this species in India further north to Rajasthan. This species is not known to occur elsewhere in the northern and north eastern parts of India, along the Himalayas (Menon 1962). Thus the occurrence of this species in China presents an interesting example of discontinuous distribution.

C. leucopunctatus belongs to the family Channidae. The fishes of this family are air-breathing and are commonly called murrels. They constitute one of the important groups of food fish.

This species resembles *C. marulius*, but can be easily distinguished from it by the lack of a black white-edged ocellus on the caudal fin and numerous white spots on the caudal and dorsal fins.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Dr. A. P. Kapur, Director, Zoological Survey of India, Calcutta for providing with necessary facilities and to Dr. Asket Singh, Officer-in-Charge, Northern Regional Station, Zoological Survey of India, Dehra Dun for encouragement.

NORTHERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
DEHRA DUN,
December 7, 1972.

R. N. BHARGAVA

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14. A SPECIAL METHOD OF FISH TRAPPING IN RIVER GANGA AT VARANASI

(*With a text-figure*)

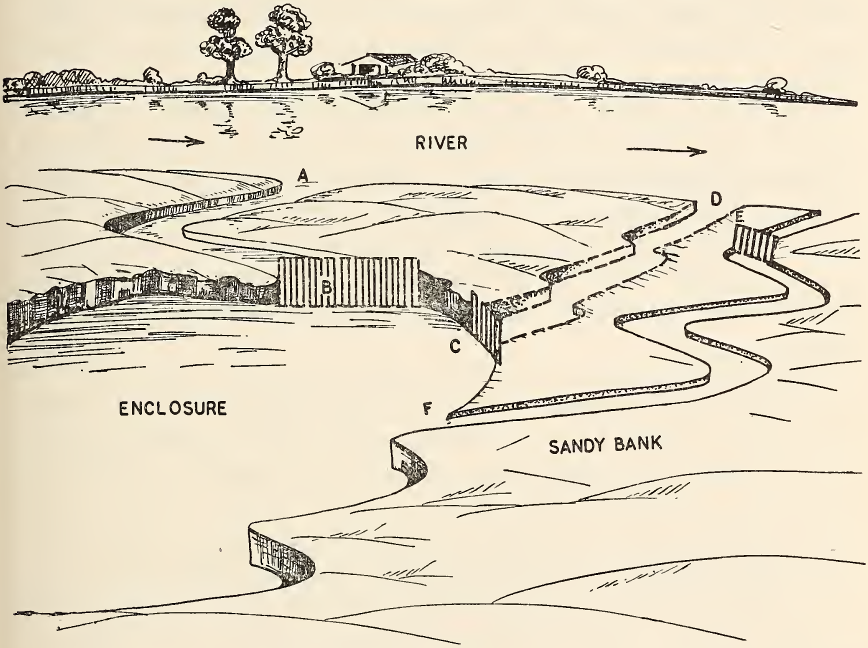
Fishing methods used in river Ganga have been described in some detail by several earlier workers. In the present communication, a method, locally known as *Koli*, which had not attracted the attention of earlier workers, and is extensively employed in Ganga at Varanasi, is described. The method is effective for catching *Chela* spp., *Aspidoparia* spp., *Puntius* spp., *Mugil* spp., *Mystus* spp., etc. along shallow, sandy, banks where the current is sluggish. Two to six fishermen, two to four long bamboos (4m-5m), one or two short bamboos (2m-3m), four short "Y" shaped sticks (0.5m-1m), one big split bamboo or reed screen (1.8m-2.4m × 3.6m-4.5m), one rectangular split bamboo screen (0.3m-0.6m × 3.6m-4.5m), another comparatively smaller split bamboo or reed screen (0.6m-0.9m × 1.5m-2.4m), one to two iron discs (0.3m-0.4m diameter) and a few baskets of split bamboo are essential prerequisites for *Koli* fishing.

A small water area of 0.3m-0.4m depth along the shallow, sandy, bank of the river is enclosed by raising temporary sand bunds, (0.61m-0.91m high). This enclosure has one or more openings connecting it with the main river (A, Fig. 1). The enclosure remains connected with the river all through night but is closed by bamboo screen, straw or sand quite early in the morning before sunrise, when the fishing operation starts. (B, Fig. 1). The fishes which enter the enclosure from the main river during night are enclosed and their escape is thus prevented. The fishes, so trapped are fished out almost completely in the following three operations, which take about two hours time.

1. A wide, shallow, channel (4m-8m width) is prepared by the side of the enclosure, by removing the sand from the bed with the help of iron disc. This channel connects the enclosure with the river. A large platform screen is made in the enclosure near its junction with the channel (C, Fig. 1), by spreading the screen on two long bamboos placed horizontally on four "Y" shaped sticks fixed in the bed. The rectangular split bamboo screen is then fixed in a slanting position in such a way that the lower side remains embedded in the sand bed of the enclosure, while the upper side rests a little above the screen platform. An opening is now made removing the sand at the mouth of the channel (D, Fig. 1) to allow the flow of water into the channel. The fishes, mostly *Chela* spp., *Aspidoparia* spp., *Mugil* spp., etc. trapped in the enclosure, move towards the channel and finding a barrier of the slanting screen, jump, and are thus stranded on the horizontal platform. These fishes are then collected by rolling the platform from both the sides and then the catch is kept in the basket.
2. In the second operation, the rectangular split bamboo screen is changed from slanting to vertical position. The fishermen, thereafter, start scaring the fish by beating the water in the enclosure and move towards the vertical screen. The fishermen use the short bamboos, holding them by hand and beating the water horizontally. As the fishermen approach the vertical screen, another vertical screen is fixed behind them in the enclosure, thereby reducing the area of operation and checking the escape of fishes into the enclosure again. In this process, the fishes which strike against the bamboo or legs of the fishermen, are caught by hand. Catfishes like *Mystus* spp., *R. rita,* etc., which do not jump over the horizontal platform in the first operation, are thus trapped

and are removed by hand by the fishermen.

3. Fishes that have escaped capture, during first two operations are generally small sized (5-10 cm) and are caught in the third and last operation. A shallow, narrow drain (0.8m-1m) is dug by removing sand by iron disc as in the second operation, connecting the enclosure with the river. A screen is fixed in the drain vertically near its junction with river (E, Fig. 1). Water is allowed to pass through the drain removing the sand at the junction of enclosure and channel (F, Fig. 1). After, it is noticed that the movement of fishes into the drain from enclosure has stopped, the mouth of the drain at the enclosure is closed by putting sand. Most of the fishes get stranded near the screen while some get trapped on the wet sand after the flow of water ceases. Both are picked up by hand.



The catch is collected in baskets and taken to fish market. The enclosure is again connected with the river by removing the screens for operation on the next morning.

This method is employed all round the year except the rainy season (June-September). The average catch of the fish per operation per day ranges from 10 kg to 30 kg. The effectiveness of this method may be due to the fact that on the approach of dusk, small sized fishes moving along the shallow banks of the river, enter the enclosure, which are devoid of current to secure rest and protection. The efficacy of this method, particularly during dark nights, is further supported by the observations of the catch during moonlit nights, which is generally much less than the catch on dark nights.

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ALLAHABAD,
November 13, 1971.

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15. CANNIBALISM AMONG SCORPIONS

The question whether scorpions ever eat each other has not been discussed in Max Vachon's admirable Note on "The Biology of Scorpions" (*JBNHS 54*, No. 1). Having recently kept some of these interesting arthropods, I offer the following observations.

(1) On 3-xi-'73 I obtained a female of the common "grey-and-yellow" type (cephalothorax and abdomen grey on top, legs and pedipalps yellow or pale orange) with some 20-25 babies crawling over her. The babies were so recently born that they were still colourless, only developing the typical colouring some 4-5 days later. Deciding to test the widespread belief that a mother scorpion offers her body for her babies' first meal, I kept the family in a glass jar with no food supply.

The babies died off one by one, while at the same time there was a decrease in the number of bodies (both living and dead) which could be seen. Since I feel reasonably certain that the mother ate none of her babies, this suggests that the stronger progeny devoured the weaker. By early December all the babies had died. Twelve bodies were counted in the jar, and these were left for some more days, during which the mother never touched them. That she was very hungry was proved by the eagerness with which she seized and totally devoured a cricket which I offered, after removing the babies' dead bodies, on 24 December.

The common belief in scorpions' matriphagy thus appears to be just another popular superstition.

(2) On 26-x-'73 two full-grown "grey-and-yellow" scorpions were found, a few inches apart, under a large stone. Not possessing the knowledge to sex them, I assumed that they were male and female, and kept them together in a large glass jar. As food, they were offered large cockroaches; these however seemed to inspire the scorpions with alarm, and were never captured and eaten in spite of being left there

for many days. For many subsequent days I was prevented from catching crickets, and it thus came about that the two scorpions fasted for some seven weeks.

One day, about the middle of December, I examined the jar and found the slightly larger scorpion dead, with the slightly smaller insect in the act of feeding on its left side. All the legs on this side had been bitten off, and the left pedipalp had been sucked hollow; there was also a fairly extensive wound on the body's left side between the cephalothorax and the abdomen.

This observation suggests that scorpions—at least of the same generation—do eat each other if no alternative food is available.

(3) On the other hand, I have three small scorpions (two "grey-and-yellow", one black) which have lived together peaceably in the same jar for the last two months, during which their food supply of crickets and grasshoppers has had to be very irregular. When these insects encounter each other, they feel one another with their pedipalps and then separate in different directions. They can even crawl over each other's bodies without provoking any aggressive response.

Those persons who may be interested in making further observations, may rest assured that scorpions cannot climb perpendicular glass surfaces and may be safely kept in deep glass jars. The bottom of the jar should be covered in sifted soil, and a piece of coconut shell, fitted with a wire hook on top for purposes of easy removal, makes a satisfactory "stone" for the scorpions to hide under, being light enough to cause no damage in case it is accidentally dropped into the jar.

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January 11, 1974.

16. *ALEURODOTHRIPS FASCIAPENNIS* (FRANKLIN) PREDATORY ON COCCIDS AND ALEYRODIDS

(*With a text-figure*)

Franklin (1908) described the species *Cryptothrips fasciapennis* based on a solitary female on the leaf of lime in West Indies and in the very next year erected the genus *Aleurodothrips* with *C. fasciapennis* as the Type. Priesner (1949) synonymised *Cephalothrips spoinous*. Bagnall (1909) subsequently transferred it to the genus *Micracanthothrips* (Bagnall 1914). *Aleurodothrips fasciapennis* enjoys a wide distribution being recorded from Barbados, Bermuda, Sri Lanka, China, Cuba, Fiji, Florida, Formosa, Hawaii, Java, Jamaica and even from Brussels and New York. This species was first recorded in this country by the author in 1964 feeding on coccids on the leaves of Palmyra (*Borassus flabellifer*). Since then this species has been recorded more frequently and recently a good series was taken on drying *Pandanus* infested with coccids, in West Bengal. Its introduction from Java to Fiji for the control of *Aspidiotus destructor* on coconut palms and its close association with other aleyrodids and coccids point to the possibility of its usefulness in biological control.

Examination of a good series of both sexes offered good evidence for the presence of major and minor females and oedymerous and gynaecoid males. While the genus *Aleurodothrips* is characterised among other features by the banded wings, lack of epimeral suture on pronotum, the divided pelta and by the strongly developed fore-

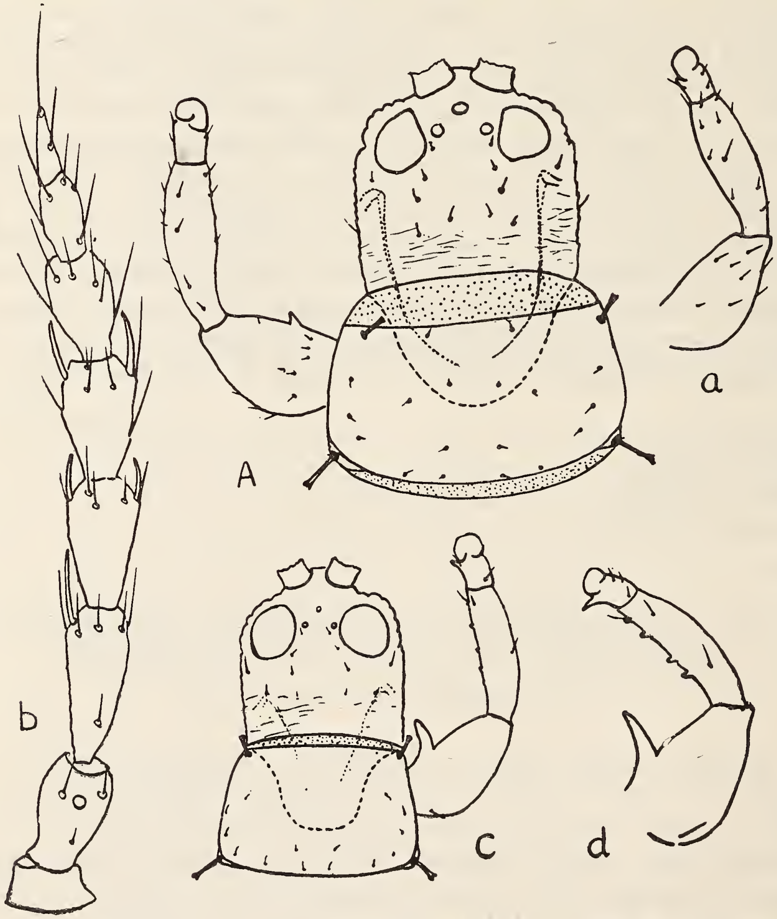

Fig. 1. *Aleurodothrips fasciapennis*: A. Head & Prothorax of major female. a. Forelimb of normal female; b. Antenna of female; c. Head and prothorax of normal male; d. Foreleg of oedymerous male.

femoral spur or tooth in the males, the distinct presence of a comparatively small spur on the forefemora of major females appears to be of interest. This is absent in the minor and normal females. Correspondingly the three or four seta bearing warts become more emphasised in oedymerous males and absent in gynaecoid males (Fig. 1).

While Stannard (1968) has characterised this species in detail, it would be proper to give the range of essential measurements (in microns) so as to have an idea of the intraspecific variation of this important species, information on which is lacking.

Macropterous female (*male*):

Head 112-115 long (92-96), 124 (99-106) wide across eyes, 129-131 (99-106) across cheeks and 124-126 (97-103) at base. Eyes 46 (44) long, 37-44 (34-36) wide. Antennal segments, 1-8, length (width):

Female: 18-23 (23); 32-34 (23); 51-53 (18-21); 44-46 (21-23); 37-39 (21-23); 32-34 (18); 25-28 (11-14); 23-25 (7).

Male : 14-16 (18-21); 25-28 (18); 44-46 (14-16); 37-41 (21); 32-37-(18-21); 30-34 (16-18); 23 (11); 18-23 (7-9).

Mouth cone broadly rounded, 122-124 (92-101) wide at base and 71 (48-55) at apex.

Prothorax 103-115 (76-94) long, 131-140 (103-115) wide at anterior margin, 92-107 (133-166) across posterior; anteroangulars 16-21 (11-16), epimerals 16-23 (21-23) expanded at apex. Forefemora 80-92 (80-103) wide, foretarsal tooth absent in female, with a minute tooth in males, 5-9 long; forefemora of normal and minor females unarmed, major females with *a distinct spur;* forefemora of males with a strong tooth, reduced in gynaecoid males and well developed in oedymerous males, 21-32 long; foretibia of males with a series of 2-3, rarely 4 emphasised tubercles better developed in oedymerous individuals. Forewing 520 (395-441) long, comparatively narrow, and without double fringes; basal wing bristles very short 5 (5-7), 5-7 (7-11), 7-11 (9-11) long, expanded.

Abdomen 226-237 (136-162) wide at base, 249-260 (124-136) at middle, 158-169 (90-102) and 79-102 (68) across VIII and IX. B1-B3 of IX 39-41 (56); 64-69 (34-36) and 69 (69) long. Tube 94 (80) long, 46 (34-37), 34(25-34) and 23 (23-32) respectively wide at base,middle and apex. Anal setae 69-80 (46-73) long.

Total body length: 1.051-1.445 (0.836-0.842) mm long.

Material: Sibpore (West Bengal), drying *Pandanus,* 27-i-72; 14 females, 8 males, Kolathur, Kerala, Palmyra leaves, 31-vii-64; 10 females, 9 males; Calicut (Kerala), grass, 4-xi-63, 8 females, 6 males; Chalakudi (Kerala), bamboo leaves, 5-xii-63, 4 females, 2 males; Mangalore (Mysore), grass, 26-i-64, 4 females, 2 males.

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17. NOTE ON THE PECULIAR BEHAVIOUR OF DRAGONFLIES

It is now known that certain dragonflies have the habit of following, without any apparent reason, moving objects both animate and inanimate. For example, Acharya (1961) and Worth (1962) reported unspecified dragonflies following bicycles and Corbet (1962) reported *Brachythemis leucostcta* following a walking man over a concrete pavement in Africa. I have observed an *Ictinogomphus rapax* Ramb. following a moving tram car for about 10 metres on a June evening in 1966, and a *Pantala flavescens* (Fab.) following for about 6-7 metres another tram car in an afternoon of April, 1968. On the latter occasion the dragonfly was found to hit against the roof of the vehicle. One morning in July, 1970, some examples of *Crocothemis servilia* (Dr.) were observed to follow motor vehicles running along a main trunk road in the suburbs of Calcutta for about 4 to 5 metres and then to come back their original place. Sometimes several *Diplacodes trivialis* (Ramb.) and *Brachythemis contaminata* (Fab.) dragonflies are found to follow men walking along grasslands.

Acharya (1961) considered this behaviour of dragonflies as fun, but Worth (1962) considered it as hunting strategy. But Corbet (1962) did not consider it as a preying technique because no small-winged insect was found to rest on the concrete pavement. Similarly, no winged insect could possibly be resting near moving vehicles and men. From the above facts it is clear, as Corbet (1962) has already suggested that the response of dragonflies towards moving objects offers promising field for research in odonata behaviour.

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CALCUTTA,
October 30, 1971.

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18. FOOD PREFERENCES IN THE LARVAE OF TWO MOTHS: *SPODOPTERA LITURA* F. (FAM. NOCTUIDAE) AND *DIACRISIA OBLIQUA* WALK. (FAM. ARCTIIDAE)

(*With a text-figure*)

The larvae of the moths *Spodoptera litura* and *Diacrisia obliqua* are serious pests of cruciferous plants in Saharanpur (U.P.) and are responsible for considerable damage. The larvae of the former (*S. litura*) hatch out in early September, and have an average larval period of about ten days completed in five moults and mainly feed upon cauliflower leaves of the early crop. The larvae of the latter (*D. obliqua*) hatch out in late October, and have an average larval period of about thirty eight days completed in six moults and are mainly pests on raddish leaves. In the light of thermal constant derived by Muggeridge (1942)[1] in regard to the development of *Pieris rapae*, difference between the duration of their larval periods—10 days in the former and 38 days in the latter—is perhaps accountable since the normal room temperature recorded in early September was around 30°C as against 20°-18°C in late October.

With a view to determine the extent of food preference in the larvae of the two moths (*S. litura* and *D. obliqua*) their comparative rate of feeding during the entire larval period was studied on their usual food (cauliflower leaves in the case of *S. litura* and raddish leaves in case of *D. obliqua*) as well as unusual food (raddish leaves in case of *S. litura* and cauliflower in case of *D. obliqua*), as indicated by the faecal matter produced by them in 24 hours.

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[1] MUGGERIDGE, J. (1942): The White Butterfly (*Pieris rapae* L.): Its establishment, spread and control in New Zeland. *N. Z J. Sci. & Tech.* 24(3).

S. litura lays eggs in early September on the underside of the leaves of cauliflower plants, usually of those situated on the periphery of the fields. *D. obliqua* lays eggs from late October to early December on the underside of the leaves of raddish plants. The leaves of the host plants with the corresponding eggs on them were taken to the laboratory. Eggs were reared in glass-chimneys and were observed every eight hours for hatching.

Of the freshly hatched larvae, twelve in each case were placed in a large petri-dish covered over by a rearing glass-chimney and fed on leaves (of cauliflower or raddish, as per the requisite of the experiment), which were replaced by fresh ones every day, between 10.00 and 11.00 a.m. During the same period every day, the faecal matter accumulated in the petri-dish during the past 24 hours was collected by means of a fine camel hair brush. The faecal matter was then weighed as such, as well as after drying it in oven for 24 hours at 100°C, with a view to obtain comparative rate of feeding of the larvae of the two moths on their usual and unusual foods during their entire larval periods, till they stopped feeding preparatory to pupation.

RESULTS

The comparative amounts of faecal matter (wet without drying) produced by twelve larvae each of *S. litura* and *D. obliqua,* during their entire larval period are shown in Fig. 1. These results may be interpreted to suggest the following:–

1. The larvae of *S. litura* have preference for cauliflower leaves for their food as indicated by the fact that twelve of them produce 19.8 gm of faecal matter (wet) when fed on cauliflower leaves (their usual food) but produce only 13.2 gm of it when fed on raddish leaves (not their usual food).

2. The larvae of *D. obliqua* on the other hand, do not have any appreciable preference for any one of them since they produce 18.8 gm of faecal matter when fed on raddish leaves (their usual food) as against 18.4 gm when fed on cauliflower leaves (not their usual food).

3. Although the larval period in *S. litura* is completed in 10 days and in *D. obliqua* in 38-39 days, the total amount of faecal matter produced is not much different indicating thereby that the damage done in a day by the larvae of the former is nearly four times of that done by the larvae of the latter.

4. The shorter larval period in *S. litura* is perhaps due to a higher

temperature (room temp. about 30°C) during September and the consequent higher metabolic activity, as also co-related by their higher food intake. Evidently it is on this account that the early cauliflower crops are prone to a much higher damage than the later crops when temperature is lower.

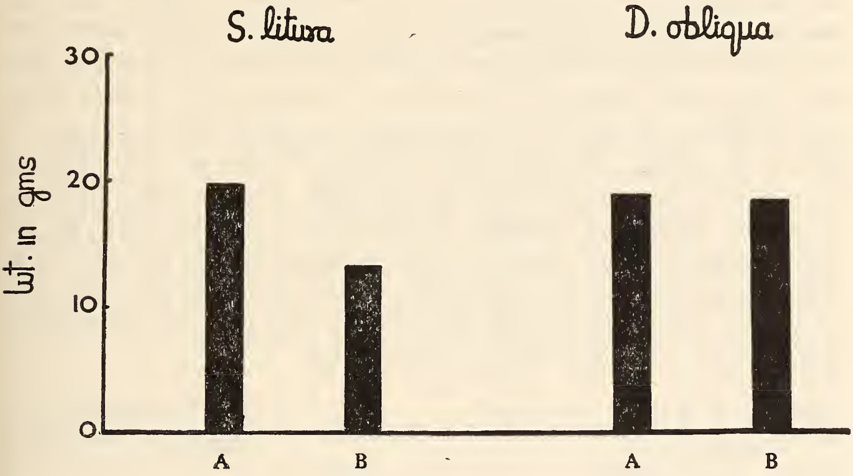

Fig. 1. — Comparative amount of faecal matter (wet, without oven — drying; in gm) passed by 12 larvae each of *S. litura* and *D. obliqua* during their entire larval periods extending over 10 days (5 moults) in the former and 38-39 days (6 moults) in the latter. *A* — While feeding on their usual food (cauliflower leaves for *S. litura* and raddish leaves for *D. obliqua*); *B* — while feeding on their unusual food (raddish leaves for *S. litura* and cauliflower leaves for *D. obliqua*).

ACKNOWLEDGEMENTS

I am extremely grateful to Dr. Surendra Sharma, Professor of Zoology, M. S. College, Saharanpur, for guidance and encouragement. Also I am thankful to the College authorities for the facilities and to Dr. Fennah, Director, Commonwealth Institute of Entomology, London, for identification of the moths.

DEPARTMENT OF ZOOLOGY,
M. S. COLLEGE,
SAHARANPUR, (U.P),
December 31, 1971.

ASHA BASSI

19. *ORTHETRUM GLAUCUM* (BRAUER) PREYING UPON *PALPOPLEURA SEXMACULATA SEXMACULATA* (FABR.) (ODONATA: LIBELLULIDAE)

Hobby (1934) describes the dragonflies as one of the best known entomorphagous predators. According to Tillyard (1917) they are the most powerful determining factors in preserving the balance of insect life in ponds, rivers, lakes and their surroundings. They not only prey upon other groups of insect but do not spare even weaker members of their own kind. An interesting case was observed during our visit to the Corbett National Park (U.P.) in November 1971. A specimen of *O. glaucum* was observed resting on a grass stalk, (grasping a smaller dragonfly) between its extended legs. The head of the prey had already been devoured and its thorax was in the process of being consumed. The two specimens were collected at this stage and no further observations could be recorded.. The prey was later determined to be a specimen of *P. s. sexmaculata.*

Zoological Survey of India,
13, Subhas Road,
Dehra Dun, (U.P.),
April 24, 1972.

R. N. BHARGAVA
MAHABIR PRASAD

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20. ARCHIDIACEAE FROM WESTERN INDIA

(*With fifteen text figures*)

Archidiaceae is a small family consisting of a single tropical genus *Archidium* Brid. They are tiny perennial mosses growing on ground in meadow, barren places usually with high silicious content. A noteworthy characteristic of the genus is the large polyhedral spores, the largest among the mosses so far known. Those of *Archidium alternifolium* (Hedw.) Mitt. are as much as 200 μ in diameter.

Genus *Archidium* Brid., *Bryol. Univ.* I:747.1826.

Being the only genus of the family, its characters are the same as those of the family Archidiaceae. They are small perennating mosses, perennating by means of underground protonema and stolonlike branches. Narrow, ovate, lanceolate to lanceolate-subulate leaves with comose tuft arise on the upperside. Leaf base cells rectangular to quadrate. Upper leaf cells prosenchymatous. Nerve rather homogenous.

Sporophyte immersed, with or without reduced seta. Capsule spherical, sunken at the tip of the gametophyte and with a bulbous foot covered by delicate calyptra. Stomata and columella absent. Varied size of the polygonal spores range from 100 to 200 μ in diameter.

There are four species in India namely *A. indicum* C. Muell., *A. microthecium* Dix. et P. Vard., *A. octosporum* Dix. et. P. Vard. and *A. birmannicum* Mitt. et Dix. (Bruhl 1931). Out of these *A. birmannicum* Mitt. ex. Dix. and *A. indicum* C. Muell. are common in western India. *A. birmannicum* Mitt. ex Dix. recorded by Sedgwick (1919) from Jog Falls, Dharwar and Karwar in Karnataka (Dixon 1921), whereas the *A. indicum* C. Muell. has been recorded by O. N. Handoo (1966) from Pachmarhi in Madhya Pradesh and by Norkett (1966) from Bhakra-Nangal in Punjab. *A. indicum* C. Muell. in western India is a new record. The specimens of the two species were collected at Khandala, Borivli (Bombay), Mumbra and Matheran.

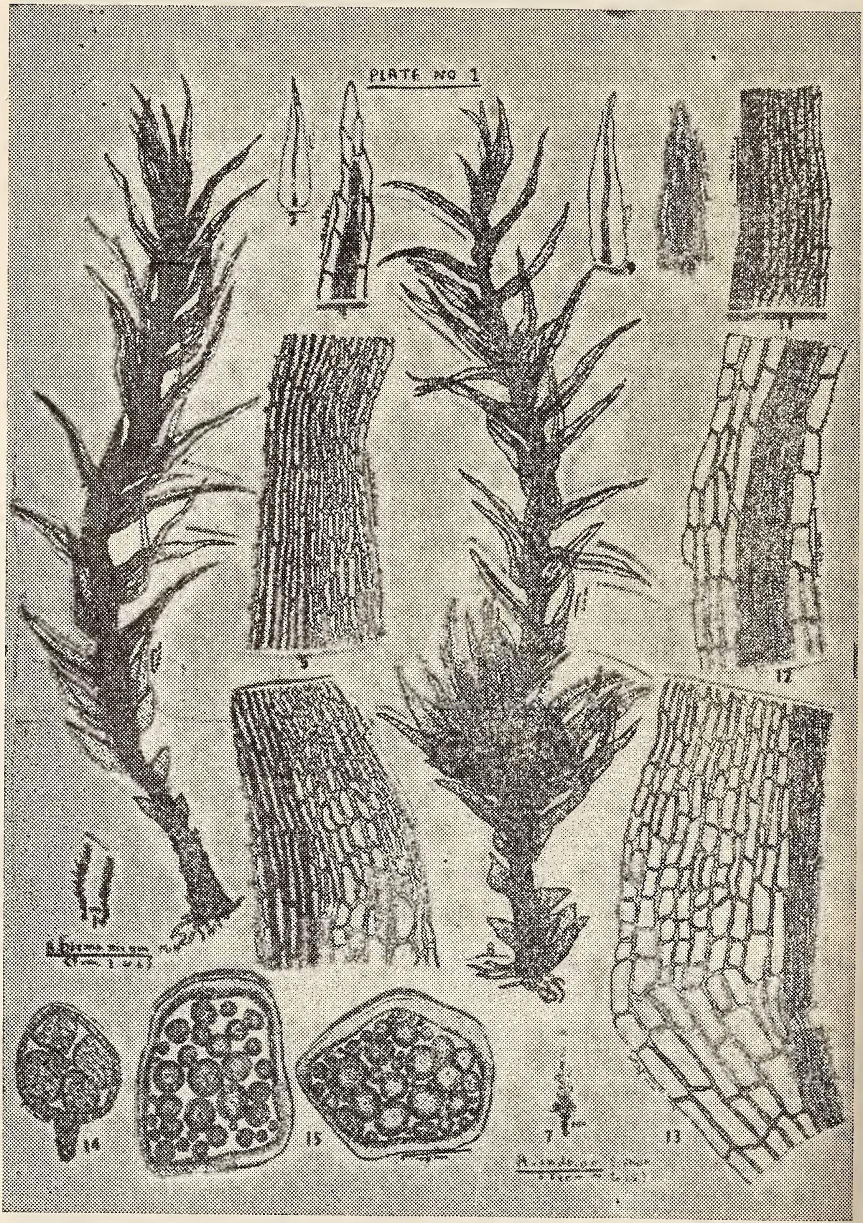
KEY TO SPECIES

Plants comose, sporophytes on innovations, leaves widely ovate-lanceolate with broad at basal and middle region, slowly narrowed at apex, percurrent nerve .... *A. indicum*

Plants non-comose, sterile, lax leaved, leaves broad at base, gradually narrowed at apex, lanceolate, nerve percurrent, concolor ....*A. birmannicum*

Archidium birmannicum Mitt. ex Dix., *J. Ind. Bot. Soc.*, 2:175, t. 1, 1921—(Figs. 1-6).

Non-comose, sterile plants of 5-8 mm high growing on moist ground with lax leaves (Figs. 1-2). Leaves narrow in the apical and middle regions, broad at the base, ovate-lanceolate, 0.5 to 0.7 mm in length and 0.2 to 0.3 mm in breadth (Fig. 3). Nerve concolor, percurrent, reaching below the apical cells (Fig. 4). Upper cells prosenchymatous, subrectangular to irregularly rhomboidal, 13 μ long and 6-7 μ broad (Fig. 5). Leaf base cells rectangular to subrectangular quadrate, 15 μ long and 8-10 μ broad. Border leaf base margin with two rows of rhomboidal to rectangular cells. These cells are 20 μ long and 6 μ broad. Leaf margin slightly undulated (Fig. 6). Occur on moist ground at Khandala near Railway Station, Nov. 1966; Mumbar hill, National Park at Borivli, (Bombay); Matheran, near Railway Station, July 1970.



Archidium indicum C. Muell., *Flora.* 71:8, 1888. (Figs. 7-15).

Plants comose, in the form of glossy green tufted patches, reaching a height of 1 cm and growing on moist rocks and ground (Figs. 7-8). Stem with innovations. Ovate-lanceolate leaves broad in middle and basal region, 0.5-0.7 mm long and 0.2-0.3 mm broad, acuminate (Figs. 8-9). All the leaves alike. Upper leaf cells prosenchymatous, chlorophyllose, hexagonal to rhomboidal-rectangular, 29 μ long and 5-9 μ broad (Figs. 11-12). Leaf base cells rectangular to quadrate, 22.4 μ long and 11.7 μ broad. Leaf margin slightly undulated (Fig. 13). Leaf apex cell triangular, pyramidal or dome-shaped, cutting new cells on tree sides resulting in a new leaf laterally (Fig. 10). Nerve percurrent.

Sporophyte present on innovating branches of stem. Seta reduced. Foot bulbous foot, immersed cleistocarpic capsule. Sporophyte reaching a length of 0.9 mm (Figs. 8 and 14). Spores few, 10 to 12, large, hexagonal to polygonal, with yellowish exosporium 6.9 μ in thickness. Spores brownish yellow in colour, with 125.8 μ in diameter. They contain a large number of oil globules (Fig. 15).

Occurrence: This tropical comose moss grows on barren rocks at Khandala, December 1968.

Discussion: A comparative analysis of the distinguishing characters of *A. birmannicum* Mitt. ex Dix. and *A. indicum* C. Muell. shows that these two species differ from each other in regard to their shape of leaves, sterility or fertility of the plant and size of the spores. Leaf of *A. birmannicum* Mitt. ex Dix., is broad at base and gradually narrow from middle to apical region whereas the leaf of *A. indicum* C. Muell., is broad in the basal and middle regions and highly acuminate. Another important differentiating character is sexuality. *A. birmannicum* Mitt. ex Dix. is mostly sterile. Sporophyte of *A. indicum* C. Muell. has reduced seta on innovating stem. Lastly the spores of *A. indicum* C. Muell. are large, 125 μ in diameter, polygonal in shape and limited 10-12 in number.

ACKNOWLEDGEMENTS

I am grateful to Dr. T. S. Mahabale, F.N.I., F.N.A.Sc., F.A.Sc., F.B.S., Professor of Botany, Maharashtra Association for Cultivation of Science, Poona-4, for guidance and help. I am also thankful to Mr. A. H. Norkett of British Museum (Natural History), London, for the determination of the species.

BANDODKAR SCIENCE COLLEGE,
THANA, MAHARASHTRA STATE,
November 18, 1972.

G. T. DABHADE

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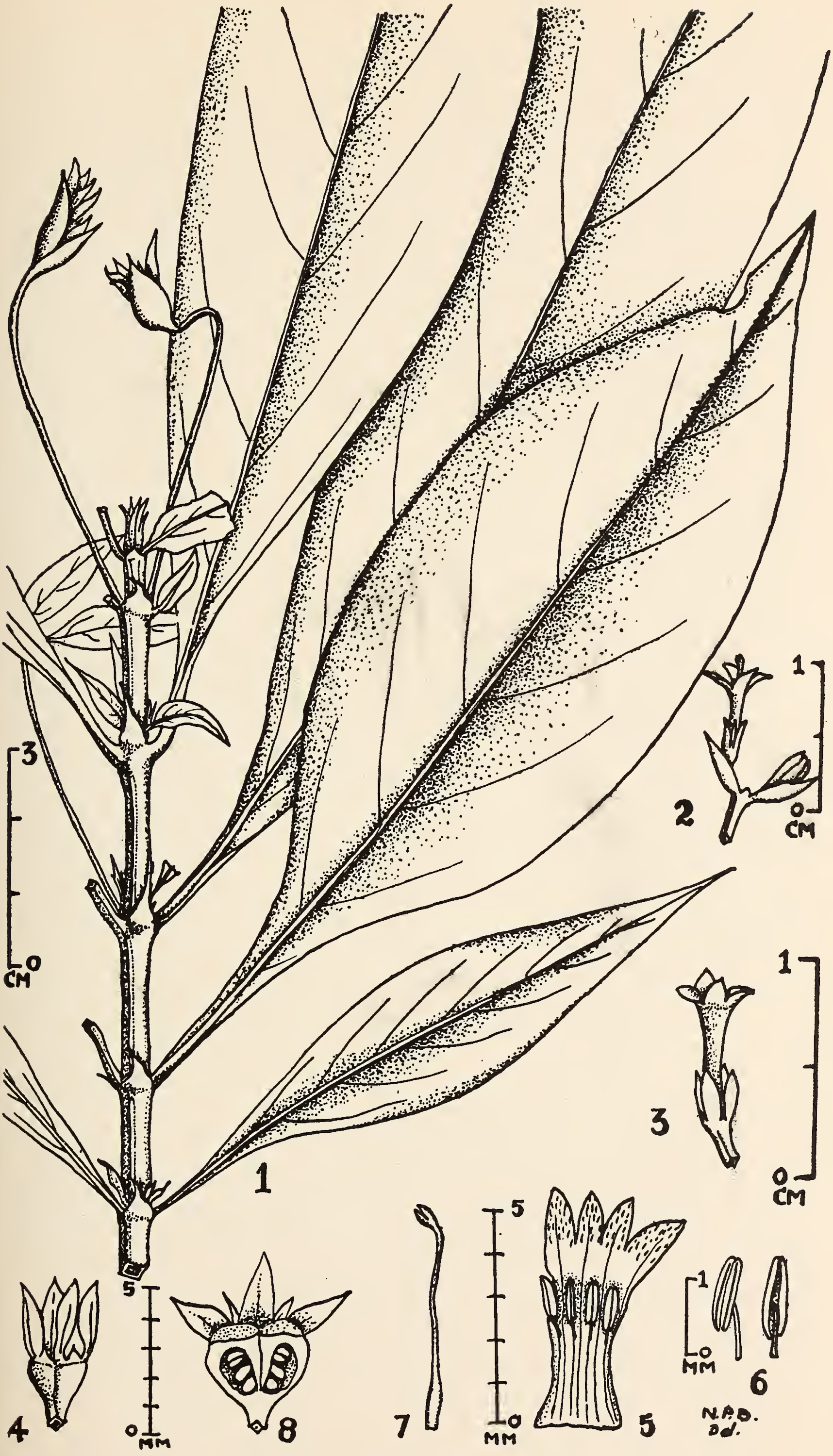
21. *HEDYOTIS TAVOYENSIS* BALAKR. (RUBIACEAE)— A NEW SPECIES FROM BURMA

(*With a plate*)

Hedyotis tavoyensis sp. nov.

Pertinent ad sectionem *Diplophragma* Wt. & Arn., affinisque est H. *eleganti* Wall. ex Hook. f., a qua tamen differt stipite acute angulato et saepe alato, stipulis maioribus glanduloso—pectinatis, petiolis longioribus inflorescentia axillari longe pedunculata.

Frutex ad 1 m altus, erectus, glaber, caule principe tereti, levi, ramis et ramulis acute quadrangularibus, saepe ad angulos aliquantum alatis. Folia glabra, chartacea, crassa, sub-olivacea cum sicca, pallida infra, fusciora supra, elliptico—oblonga, lanceolata, acuta vel acuminata ad utrumque apicem, 10-15 cm longa, 2.5-5.5 cm lata, marginibus integris, nervo medio supra impresso; nervi laterales 6-10-jugi, distincti, caeteris obscuris; petioli 0.5-2.0 cm longi, ad basin lati, anguste alati versus laminam. Stipulae triangulares, acuminatae, 5-8 mm longae, 3-4 mm latae ad basin, marginibus glanduloso-pectinatis, saepe intergris, raro revolutis. Cymae glabrae, axillares, solitariae, longe pedunculatae, pedunculo principe 8-14 cm longo; rami primarii trichotomi, 4-7 cm longi, ornati bracteis duabus ovato-oblongis acutis, 1-2 cm longis, 5-8 mm latis; rami secondarii verticillatim dispositi ad apicem; bracteis ornati similibus sed minoribus. Flores cymose capitati ad apicem ramorum ultimorum; bracteis ovatis acutis, ± 0.5 cm longis, milliter purpureo-nitentibus. Calycis laciniae 4, persistentes, ± 2.5 mm longae, dentibus subulatis ad apicem glandulosis interpositis, pallide purpureis. Corolla alba, purpuree tincta, ± 0.5 cm longa; laciniae 4, valvatae, ± 1.5 mm longae, subobtusae, pilis albis adpressis mollibus intus vestitae. Stamina 4, prope os corollae inserta; antheris longitudinaliter dehiscentibus. Ovarium biloculare, compressum; stylus paulum protrudens supra corollae tubum; stigmate bilobo. Capsula obovoidea, turbinata, ± 3 mm longa, calycis dentibus ovatis subacutis persistentibus ornata.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Hedyotis tavoyensis Balakr.
1. plants; 2. cymule; 3. flower; 4. calyx; 5. corolla, split open; 6. stamens; 7. style; 8. l.s. of fruit.

BURMA: Talaingya Chaung, Tavoy, Alt. 900 m, 7-2-1919, *A. T. Gage* 68 A (HOLOTYPUS in CAL); ibid. *T. T. Gage* 68 B (ISOTYPUS in CAL); Heinye Faung, Tavoy, 1000 m, 10-3-1919, *P. T. Russell* 24 (CAL); Heinye Faung, Tavoy, Alt. 950 m, 6-4-1919, *P. T. Russell* 181 (CAL); Tavoy, *sine nom. coll.* 1805 (CAL).

Hedyotis tavoyensis sp. nov. Sect. *Diplophragma* Wt. & Arn.) related to *H. elegans* Wall. ex Hook. f. but differs in the acutely angled and often winged stems, the larger glandular-pectinate stipules, longer petioles and the axillary long-peduncled inflorescences.

Shrub, up to 1 m tall, erect, glabrous; main stem terete, smooth; branches and branchlets acutely quadrangular, often slightly winged at the angles. *Leaves* glabrous, chartaceous, thick, subolivaceous when dry, pale beneath, darker above, elliptic-oblong, lanceolate, acute or acuminate at both ends, 10-15 cm long, 2.5-5.5 cm wide; margins entire; midrib impressed above; lateral nerves 6-10 pairs, distinct, ascending; reticulations obscure; petiole 0.5-2.0 cm long, broad at base, narrowly winged to the blade. *Stipules* triangular, acuminate, 5-8 mm long, 3-4 mm wide at base; margins glandular-pectinate, often entire, rarerly revolute. *Cymes* glabrous, axillary, solitary, long-peduncled; main peduncle 8-14 cm long; primary branches trichotomous, 4-7 cm long, with two ovate-oblong acute bracts, 1-2 × 0.5-0.8 cm; secondary branches verticillately arranged at the top with similar but smaller bracts. *Flowers* capitate at the top of ultimate branches; bracts ovate, acute, ± 5 mm long, slightly shining, purple in colour. *Calyx* lobes 4, large, persistent, ± 2.5 mm long, with interposed glandular-tipped, subulate teeth, tinged purplish. *Corolla* white, tinged purplish, ± 5 mm long; lobes 4, valvate, ± 1.5 mm long, obtuse, clothed with appressed white soft hairs inside. *Stamens* 4, attached near the mouth of the corolla tube; cells longitudinally dehiscing. *Ovary* 2-celled, compressed; style slightly protruding above the corolla-tube; stigma 2-lobed. *Capsules* obovoid, turbinate, ± 3 mm long with persistent ovate subacute calyx-teeth (Figs. 1-8).

ACKNOWLEDGEMENT

I am greatly indebted to Rev. Fr. K. M. Mathew, S.J. of St. Joseph's College, Tiruchirapalli for kindly rendering the description into Latin.

BOTANICAL SURVEY OF INDIA, N. P. BALAKRISHNAN
ANDAMAN & NICOBAR CIRCLE,
PORT BLAIR,
July, 17, 1973.

22. A NOTEWORTHY *SARCOPYRAMIS* FROM EASTERN HIMALAYAS

(*With a text-figure*)

Sarcopyramis humilis sp. nov. (Fig. 1)

Affinis S. subramanii Nayar, sed calycis tubo longiore, lobis calycinis longioribus, integeris, antheris subrotundatis differt.

Herba parva, 3-7 cm alta. Caulis obsolete angulatus, insicco rubescens. Folia opposita, ovato-lanceolata, 2-5.5 cm x 0.7-1.8 cm, basi obtusa vel subtruncata, apice acuta, margine ciliato-serrata, supra parace setosa, subtus glabra, supra et subtus in sicco pallide viridia, 3-5 nervia, subtus venulis transversis distinctis; petiolus 5-10 mm longus. Inflorscentia terminalis, 1-3 flora; pedicellus 2-3 mm longus;

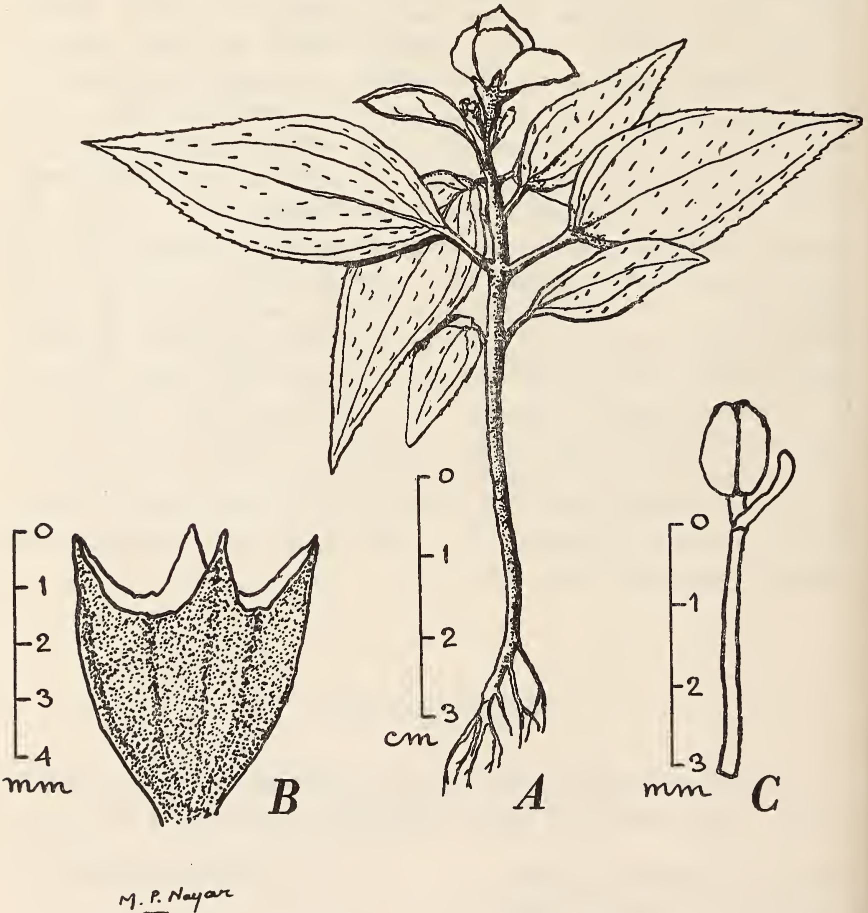


Fig. 1. *Sarcopyramis humilis* sp. nov. (After Kingdon Ward 6647)
A. Plant — Habit; B. Calyx tube; C. Stamen — dorsal view.

bractease spathulato-obovatae, 5-5.5 mm longae, margine ciliatae. Calycis tubus campanulatus, 3.5 mm × 2.5 mm, extus glaber, limbus 4-lobatus, lobibus triangularibus, 1.5 mm longis, margine haud ciliatis. Petala obovato-oblonga, 8-10 mm × 6-7 mm. Stamina 8, aequalia, filamentis 3 mm longis, antheris subrotundatis vel rotundato-oblongis, 1-1.2 mm longis, thecis apice haud divergentibus, connectivo basi 0.4 mm producto, connectivo postice 0.8 mm prolongato. Ovarium calycis tubo totum adnatum, 4-loculare. Stylus crassus, 4-4.5 mm longus; stigmate capitato, papilloso.

Typus: Kingdon Ward 6647 (K).

Herb small, 3-7 cm tall, erect. Stem obscurely angular, when dry reddish. Leaves opposite, ovate-lanceolate, 2-5.5 cm × 0.7-1.8 cm, base obtuse or subtruncate, apex acute, margin ciliate-serrate, upper surface sparsely setose, under surface glabrous, upper and lower surface when dry pale green, 3-5 nerved, transverse venules on the under surface distinct; petiole 5-10 mm long. Inflorescence terminal, 1-3 flowered; pedicel 2-3 mm long; bracts spathulate obovate, 5-5.5 mm long, margin ciliate. Calyx tube campanulate, 3.5 mm × 2.5 mm, outer surface glabrous, 4 lobed, lobes triangular, 1.5 mm long, margin not ciliate petals obovate-oblong, 8-10 mm × 6-7 mm. Stamens 8, equal, filament 3 mm long, anther subordinate or rotundate-oblong, 1-1.2 mm long, anther lobes at the apex not divergent, connective 0.4 mm long produced at the base, dorsally ends in a spur 0.8 mm long. Ovary totally adnate to the calyx tube, 4-loculed. Style thick 4-4.5 mm long; stigma capitate, papillose.

Distribution: Frontier of Tibet and Burma, Nogmung, growing amongst roots and rocks on the edge of the jungle in the shaded valleys, alt. 500-666 m, 25 Apr. 1926, *Kingdon Ward* 6647 (Holotype K).

S. humilis is allied to *S. subramanii* Nayar, but differs in the nature of calyx lobes, the size of anthers and the shape of the dorsal staminal appendage. In *S. subramanii* the calyx tube is shorter (2-2.5 mm long) and calyx lobes are slightly smaller and 2-3 ciliate; whereas in *S. humilis* the calyx tube is longer (3.5 mm long), the calyx lobes are slightly larger and margin entire. The shape of anther in *S. subramanii* is elliptic-obovate with prominently diverging anther lobes at the apex; whereas in *S. humilis* the anthers are subordinate at the apex and the anther lobes are not divergenet.

ACKNOWLEDGEMENT

I wish to express my gratitude to Dr. Subramanyam, Director, Botanical Survey of India for his encouragement.

CENTRAL NATIONAL HERBARIUM,
BOTANICAL GARDEN P.O.,
HOWRAH 3,
October 10, 1972.

M. P. NAYAR

23. A SYNOPSIS OF THE GENUS *PERILIMNASTES* RIDLEY (MELASTOMATACEAE)

(*With a text-figure*)

INTRODUCTION

I carried out a taxonomic study of several genera in the family Melastomataceae at the Herbarium, Royal Botanic Gardens, Kew, the Rijksherbarium, Leiden and Central National Herbarium, Calcutta from 1960-68. The present paper deals with the genus *Perilimnastes* Ridl. belonging to the tribe Oxysporeae Triana.

The genus *Perilimnastes* is characterised by its small branching suffruticose, rupicolous habit, its tubular or campanulate 4-angled or 8-ribbed calyx tube having long narrowly triangular calyx lobes and eight equal or subequal stamens which are inappendiculate both dorsally and ventrally. Ridley (in Journ. Roy. As. Soc. Straits Br. 79:70, 1918) established the genus on the basis of the type species *Anerincleistus fruticosus* Ridl. typified by the specimen Robinson 5453 which he transferred to the new genus as *P. fruticosa* (Ridl.) Ridl. Ridley (in Fl. Mal. Penin. 1:761, 1922) assigned this genus to the tribe Oxysporeae. The second species *Perilimnastes rupicola* Nayar from Mt. Dulit in Sarawak represents an extension of the generic range. The generic description is emended and is given below.

Perilimnastes Ridl. in Journ. Roy. As. Soc. Straits Br. 79:70,1918; Ridley, Fl. Mal. Penin. 1:761, 1922.

Shrub or Herb. Branches glabrous or puberulous, nodes glabrous or setose, subterete, young branches compressed. Leaves opposite, narrowly elliptic-lanceolate base narrowed, apex acuminate, entire, 3-nerved, cross-venules absent on the upper surface and usually indistinct on the lower surface, coriaceous or membraneous, petiolate. Inflorescence terminal, few flowered cymes. Calyx tube tubular or campanulate, 4-angular or 8-ribbed, limb 4-lobed, lobes long. Petals 4, spreading, lanceolate. Stamens 8, equal, lanceolate, apex acuminate or shortly rostrate, 1-porose, connective not produced, dorsally and ventrally inappendiculate. Ovary concrescent with the calyx tube by 8 septa, extraovarial chambers 8, all descending to the middle of the ovary. Disc present. Style filiform, stigma inconspicuous. Capsule obconic, dehiscence by 4 large valves.

Type species: *Perilimnastes fruticosa* Ridl.

Distribution: Malaya and Borneo.

The name *Perilimnastes* is derived from Greek, '*Peri*' = near, around; '*limne*' = marsh or pond, in allusion to the plants growing near water courses.

This is an interesting genus comprising 2 species so far recorded from the mountains of Gunong Tahan in Malaya and Mt. Dulit in Sarawak. *Perilimnastes fruticosa* Ridl. is endemic to the mountains of Gunong Tahan (alt. 666 m) which lies on the eastern side of Malaya. Whereas *P. rupicola* Nayar is recorded from Mt. Dulit in Sarawak. According to Ridley (Fl. Mal. Penin. 1:761, 1922) *P. fruticosa* "forms cushions about twelve inches tall in cracks of rocks in the streams." As per the field note (specimen *Synge* S. 503), it is mentioned that *P. rupicola* grows on exposed rocks by the side of rivers.

KEY TO THE SPECIES OF *Perilimnastes*

1. Branches glabrous; calyx tube 4-angled .... *P. fruticosa*
2. Branches and nodes setose, becomes glabrous when old; calyx tube 8-ribbed .... *P. rupicola*

1. **Perilimnastes fruticosa** Ridl. in Journ. Roy. As. Soc. Str. Br. 79: 70, 1918; Ridley, Fl. Mal. Penin. 1:761, 1922.

Anerincleistus fruticosus Ridl. in Journ. Linn. Soc. 38:309, 1908; Ridl. in Journ. Roy. As. Soc. Str. Br. 57:47 1911; Ridl. in Journ. Fed. Mal. States Mus. 6:148, 1915.

Distribution: MALAYA: Pahang, Gunong Tahan, *Robinson* 5453 (Holotype BM); ibid., July 1911, *Ridley* 16044 (K, BM); ibid., alt. 666 m, 22 June 1922, *Md. Haniff* & *Nur* 8309 (K).

2. **Perilimnastes rupicola** sp. nov. (text-fig.)

Affinis *P. fruticosae* Ridl., sed caulibus ad nodos setosis, foliis junioribus villosis, calycis tubo 8-costato differt.

Herba adscendens, 15-35 cm alta. *Caulis* angularis, ad nodos setosus, setis 4-7 mm longis. *Folia* opposita, aequalia, elliptico-lanceolata, 4-7 cm × 0.5-1.4 cm, basi cuneata, apice acuminata, margine integra, juniore supra et subtus villosa, ad maturitatem glabra, 3-nervia, venulis transversis indistinctis, chartacea; petiolus 4-7 mm longus. *Inflorescentia* terminalis, cymulis 4-6 floris; pedicellus 1-1.7 cm longus, glaber. *Calycis tubus* campanulatus, 3-4 mm longus, blaber, limbus 4-lobatus, lobis triangularibus, 3 mm longis. *Petala* 4, elliptico-oblonga, 10-11 mm × 4-4.5 mm. *Stamina* 8, aequalia, filamentis 4.5 mm longis, antheris anguste lanceolatis, 5.5 mm longis, connectivo basi haud pro-

ducto, inappendiculato. *Ovarium* coronatum, calycis tubo septis 8 adnatum, loculi 8. *Stylus* fiiliformis, 8-9 mm longus, glaber, stigmate punctiformi.

Typus: *Synge* S. 503 (K).

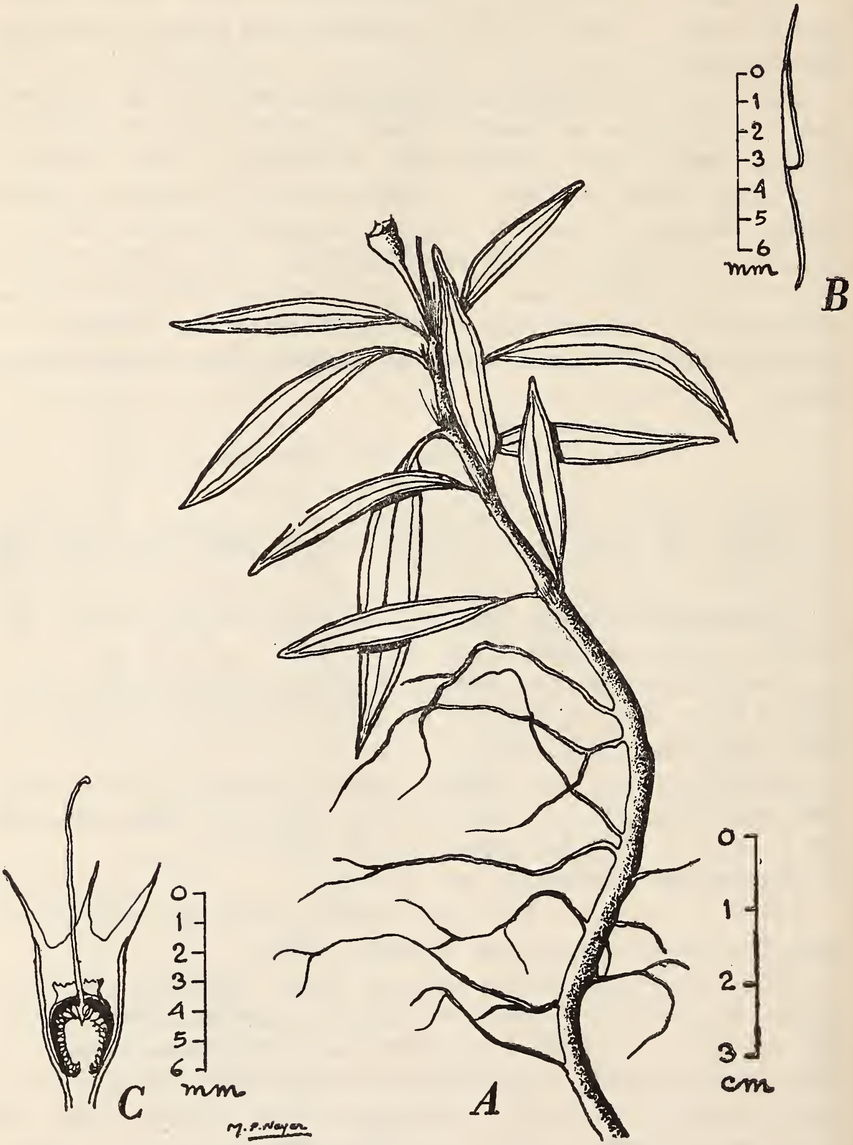


Fig. 1. *Perilimnastes rupicola* sp. nov. A. Habit; B. Stamen — side view; C. L. S. of calyx tube.

Herb, 15-35 cm tall. *Stem* angular, setose at the nodes, hairs 4-7 mm long. *Leaves* opposite, equal, elliptico-lanceolate, 4-7 cm × 0.5-1.4 cm,

base cuneate, apex acuminate, margin entire, when young upper and lower surface villose, when old becomes glabrous, 3-nerved, transverse venules indistinct chartaceous; petiole 4-7 mm long. *Inflorescence* terminal, 4-6 flowered cymes; pedicel 1-1.7 cm long, glabrous. *Calyx tube* campanulate, 3-4 mm long, glabrous, 4-lobed, lobes triangular, 3 mm long. *Petals* 4, elliptic oblong, 10-11 mm × 4-4.5 mm. *Stamens* 8, equal, filament 4.5 mm long, anther narrowly lanceolate, 5.5 mm long, connective not produced at the base, inappendiculate. *Ovary* adnate to the calyx tube by 8 septa, extraovarial chambers 8, disc present. *Style* filiform, 8-9 mm long, glabrous, stigma punctiform.

Borneo: Sarawak, Mt. Dulit, Ulu Koyan, alt. 800 m, 16 Sept. 1932, *Synge S.* 503 (K); ibid., alt. c. 800 m, 7 Feb. 1932, *Richards* 2498 (K).

This species is immediately distinguishable by the presence of bristles at the nodes of young branches and villose tomentum in young leaves. In *P. rupicola* the calyx tube is 8-ribbed, whereas in *P. fruticosa* the calyx tube is 4-angular.

ACKNOWLEDGDMENTS

I wish to express my gratitude to Sir George Taylor, Director, Royal Botanic Gardens, Kew, U.K. for all facilities during my stay at Kew from 1961-67 and to the Director, Botanical Survey of India for encouragement.

CENTRAL NATIONAL HERBARIUM,
BOTANIC GARDENS P.O.,
HOWRAH 3,
September 7, 1972.

M. P. NAYAR

24. ON THE CITATION OF *PALAQUIUM ELLIPTICUM* (DALZ.) BAILLON

Under article no. 46 of the ICBN, for the indication of the name of a taxon to be accurate and complete, for purposes of precision, it is necessary that the citation of author's name and of literature is correctly recorded. The note presents the case of the INDIAN GUTTA-PERCHA TREE, popularly called as *Panchoti-palla* in T "Cooke's Flora of the presidency of Bombay" (2:154, 1958, reprinted). The tree grows to a height of 30 m and is distributed in the Western Ghats from North Kanara southwards. The correct citation and synonymy are given below:–

Palaquium ellipticum (Dalz.) Baillon, Traite Bot. Med. Phan. 1500, 1884; Lam in Bull. Jard. bot. Bzg, ser. 3, 8:414, 1927; van Royen in Blumea 10(2):509, 1960.

P. ellipticum (Dalz.) Engler, Bot. Jahrb. 12:511, 1890; Brandis, Indian Trees 424, 1906; Gamble, Fl. Madras 4:764, 1921 (2: 537, 1957, rep. ed.); Lam in Bull. Jard. bot. Bzg, ser. 3, 7:107, 258, 1925.

Bassia elliptica Dalzell in Hooker's J. Bot. & Kew Misc. 3:36, 1851; Dalz. & Gibs. Bombay Fl. 139, 1861; Beddome, Fl. Sylv. t. 43, 1869.

Dichopsis elliptica Bentham, Gen. Pl. 2:658, 1876; Clarke in Hook. f. Fl. Br. India 3:542, 1882.

Isonandra acuminata Drury, Useful Indian Pl. 260, 1858.

The type specimen—*Dalzell s. n.* is preserved in K.

General Education Centre,
M. S. University of Baroda,
Baroda 2,
March 15, 1973.

G. M. OZA

25. ON THE OCCURRENCE OF *SYMPAGIS PETIOLARES* (NEES) BREM. AND *CANSCORA PERFOLIATA* LAMK. ON THE EASTERN GHATS

During the course of our exploration work on the eastern ghats we collected *Sympagis petiolares* (Nees) Brem., and *Canscora perfoliata* Lamk. Their occurrence in these parts drew our attention to their distribution in South India, which is mainly discussed here. The relevant data regarding the distribution of the plants were collected from Central National Herbarium, Calcutta, Forest Research Institute, Dehradun, and Botanical Survey of India, Southern Circle, Coimbatore. The herbarium sheets are deposited at Jawahar Bharati Herbarium, Kavali.

Sympagis petiolares (Nees) Brem. in Mat. Mon. Strobilanthinae 255, 1944. *Strobilanthes petiolares* Ness in DC. Prodr. 11:189, 1947, (pro-parte); Fl. Brit. India 4:458, 1855.

Under shrubs, 60-90 cm tall, *Leaves* 3-11 × 1.5-6 cm, ovate, serrate, main nerves 7-8 pairs, acuminate at both ends. *Petioles* 1-4 cm long. *Inflorescence* 6-15 cm long, interrupted, spikes or leafy panicles, terminal or from upper axils. *Flowers* 2.2-2.5 cm long, ventricose, blue. *Capsules* 6-7 mm long, oblong, glabrous when mature. *Seeds* 4, 1-1.5 mm across, hairy.

Common and abundant on hill slopes, scattered or in mixed stands among large bushes. The plants are eye catching by their beautiful blue masses of flowers. It has been collected from Udayagiri hills on the eastern ghats (A.P.).

The identity of this plant is confirmed by the courtesy of the Central National Herbarium, Calcutta.

The herbarium specimens examined: Udayagiri: *BS* 4308, 30-1-'72. DISTRIBUTION: *Assam*: Mawsami, Sonapur, 27/3 mile from Shillong to Cherrapunji, Khasia and Jaintia hills. *W. Bengal*: Kurseong, Darjeeling 3500′ alt. *Sikkim*: Sitong 5000′, Rungli 4000′. Bhutan. **Andhra Pradesh*: Udayagiri (Author's collection).

From the available data on the distribution of this plant it is a new record for south India.

Canscora perfoliata Lamk. Encycl. Method. 1:601, 1783; Fl. Brit. Ind. 4:104, 1885; Fl. Pres. Madras, 2:618, 1957 (Rep. ed.). *C. grandiflora* Wt. Icon. t. 1326.

An erect *herb*, 30-45 cm tall. *Stems* 4-angular, winged. *Leaves lax*, 2-2.5 × 0.7-0.8 cm, oblong or oblong-lanceolate, acute at both ends, glabrous, 3-nerved, sessile. *Inflorescence* dichasial cymes, terminal. *Bracts* of inflorescence 1-1.5 × 0.7-1 cm, perfoliate, orbicular-elliptic. *Flowers* 1.4-1.6 cm long, bright rose, calyx 1-1.2 cm long winged; pedicels 0.5-1.5 cm long, winged. *Capsules* 6-7 mm long.

Rare in the undergrowth, under cool and shady conditions.

The identification of this plant is confirmed by matching the herbarium sheets with those at Botanical Survey of India, Coimbatore by one of us (B. Suryanarayana).

The herbarium specimens examined: Venkatagiri hills: *BS* 3901, 26-12-'70; Udayagiri hills: *BS* 4333, 30-1-'72.

DISTRIBUTION: From Bombay to Travancore (Kerala) up to 3500′ alt. *Kerala*: (Travancore), Malabar, Wynaad. *Tamil Nadu*: Coimbatore. *Karnataka*: South Canara, North Canara. *Andhra Pradesh*: Nellore District: Venkatagiri and Udayagiri (Authors' collections).

Though the plant is recorded to occur widely in south India, it is interesting to note that, it is hitherto reported only from the western side of Deccan. Our collections are the first report for the entire belt of eastern part of the peninsula.

ACKNOWLEDGEMENTS

Our thanks are due to Prof. P. V. Bole, St. Xavier's College, Bombay for his valuable suggestions. We thank Dr. M. P. Nair, Keeper, Central National Herbarium, Calcutta; authorities of the Botanical Survey of India, Southern Circle, Coimbatore and the Forest Research Institute, Dehradun for furnishing necessary information and help. We are also thankful to UGC for financial help to conduct tour to Udaya-

giri under College Science Improvement Programme (Co SIP).

DEPARTMENT OF BOTANY,
JAWAHAR BHARATI,
KAVALI, (A.P.),
March 15, 1973.

B. SURYANARAYANA
D. RADHAKRISHNA MURTHY

26. *CHENOPODIUM AMBROSIOIDES* LINN. (CHENOPODACEAE) — A NEW RECORD FOR CHAMOLI DISTRICT IN WESTERN HIMALAYAS

Chenopodium ambrosioides Linn. *C. vulpinum* Wall. Cat. 695 B. is characterized by strong unpleasant aromatic odour and long axillary spikes of pale green flowers. Distributed mainly in Bengal, Sylhet, Western Ghats and the Deccan. Raizada (1931)[1] recorded it for the first time as a weed of waste places in and around Dehradun of the Upper Gangetic Plain.

During botanical explorations of the district, I collected this species near Palwara (140 m) in the vicinity of Hampur village at the border of cultivated fields (23.4.'71, *Nautiyal* 71). The species appears to be recently introduced into the area.

DEPARTMENT OF BOTANY,
MEERUT UNIVERSITY,
MEERUT,
April 30, 1973.

K. N. NAUTIYAL

27. BOTANICAL IDENTITY OF 'CENTURY PLANT' IN WESTERN INDIA

(*With a photograph*)

For nearly one hundred years, Indian botanists have identified the naturalised American aloe, popularly known as 'century plant', occurring in Western India as *Agave americana* Linn. The note attempts to bring to light the position of the Indian literature on the subject.

Th. Cooke (1908) in his Fl. Pres. Bombay separates *Agave americana* Linn. and *A. vera-cruz* Mill. on the basis of neck of leaf sharply constricted and neck of leaf hardly constricted respectively. He listed

---

[1] RAIZADA, M. B. (1931): Contribution to Duthie's Flora of the Upper Gangetic Plain from the neighbourhood of Dehra Dun. *J. Indian bot. Soc.* *10*:155-58.

A. americana Linn. var. *variegata* Hook. in Bombay flora stating that the native country is unknown; commonly grown as an ornamental plant in parks and large gardens; *nowhere naturalised in India* (italics mine).

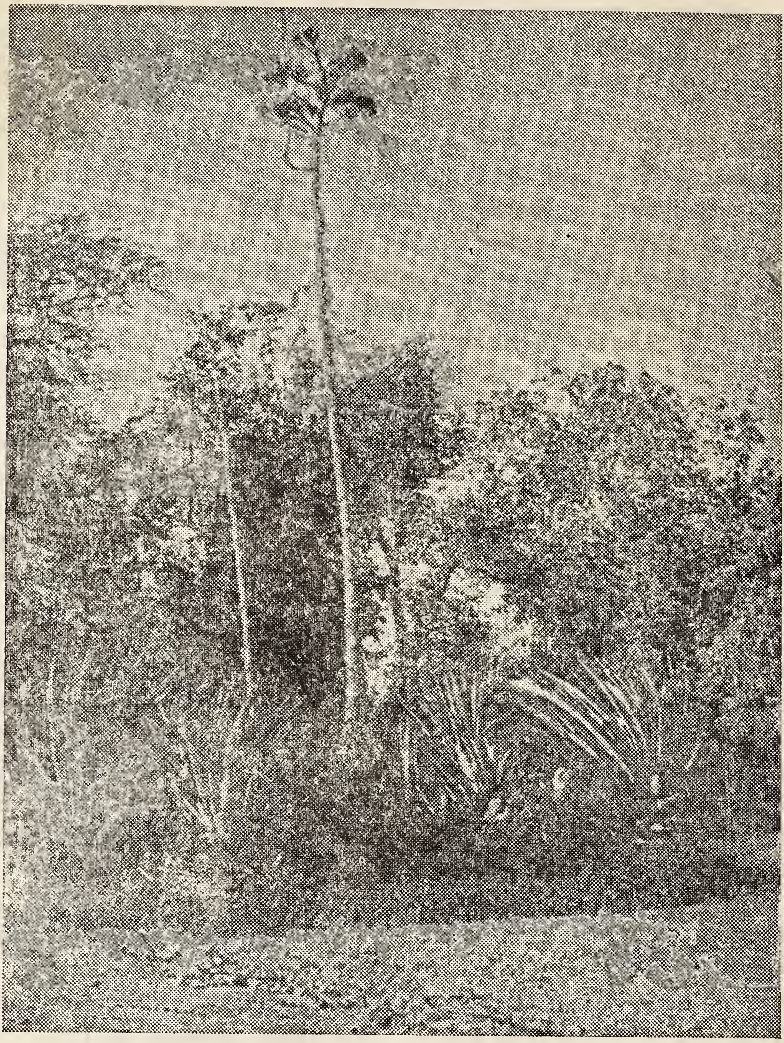
The identity of the species and its synonymy is confused. The origin and geographical distribution have not been described accurately. The Indian literature records *A. angustifolia* Haw, *A. americana* Linn., *A. sisalana* Perr., *A. vera-cruz* Mill. and *A. vivipara* Linn. for India. However, *A. cantula* Roxb. is relegated to synonymy under *A. americana* Linn. And Cooke (loc. cit.) treats *A. cantula* Dalz. & Gibs. *Bom. Fl. Suppl.* p. 93 (*not* of Roxb.) as synonym of *A. wightii* Drummond & Prain in Agric. Ledg. no. 7:91, 1960! At the same time *A. wightii* (1906) is considered as a synonym of *A. angustifolia* Haw.

H. Santapau (1967) in his "Flora of Khandala on the Western Ghats of India", p. 280, following Berger's monograph, Die Agaven, 1915, writes that the Khandala specimens (Western India) are all *Agave ingens* Berger and treats *A. vera-cruz* Mill.? in the synonymy. Berger and *Agave* monographer Gentry consider *vera-cruz* Drum. & Prain a synonym of *americana.*

Agave americana is a polymorphic species, occurring in wild forms from southern Texas to the State of Hidalgo in Mexico along the middle slopes and valleys of the Sierra Madre Oriental. Contiguous to this region it has been cultivated for its fibre, pulp, and juice for several years. Many of the larger variants, mostly polyploids, were selected for pulque culture, were propagated vegetatively by suckers, and Gentry observed them from Durango and Coahuila to Jalisco, Michoacan, and Oaxaca.

Gentry (1972, in a personal communication) states that in the Kew Herbarium there is a good specimen from Berger, from La Mortola, which he labelled as *Agave ingens*, but which Gentry interprets as *Agave lurida* Aiton, according to other specimens in the Kew Herbarium, the earliest being sent in 1883 from Ricasoli in Italy. The specimen was made up almost a century after Aiton's publication (1789) of the taxon. That taxon cannot be determined solely by the brief description given by Aiton. Berger interpreted Aiton's species in one way, Baker and R. E. Brown of Kew in another way. Gentry is inclined to accept the older Kew specimen from Italy as the correct or arbitrary guide and nominate it as the lectotype of *Agave lurida* Aiton.

Agave lurida Aiton has not been recorded from India. It is, therefore, a new record. *Index Kewensis* gives Mexico as the home of this plant.



Agave lurida Aiton — the endangered Baroda species.

The widely scattered populations of *Agave* in Kamathi Baug, Baroda, consisted of small colonies extending over few areas and numbering hundreds of individuals.

In recent years, such plant colonies have been cleared extensively to make way for common ornamental plants!

ACKNOWLEDGEMENT

The author owes a tremendous debt of gratitude to Dr. Howard Scott Gentry, Botanist, Desert Botanical Garden, Arizona, U.S.A., for

his notes and excellent literature which has served as a basis in the preparation of this note.

GENERAL EDUCATION CENTRE,
M. S. UNIVERSITY OF BARODA,
BARODA 2,
June 18, 1973.

G. M. OZA

28. ON THE OCCURRENCE OF VEGETATIVE SHOOTS AT THE CROWN AREA IN *COCOS NUCIFERA* L.

During a recent study tour along the Karnataka (Mysore) coast we saw a coconut palm of unusual interest in the vicinity of the seashore at Surathkal, 3 Km away from Mangalore city. A striking feature of this palm is the periodic production of sixty to hundred vegetative shoots in two to three rows in place of spadices. The tree is about 10 metres high and looked normal with a well developed crown and was growing on the raised bund of a cultivated land. The owner of the tree reported that this palm at no time bore fertile spadices but produced vigorously growing vegetative shoots at regular intervals.

Such vegetative shoots resembling bulbils at the crown of many palms have been reported by various authors (Davis & Basu 1969).[1]

The local people called this plant in Kannada language as 'gandu gida' (Male tree) even though they had not seen the plant in flower. It appears that attempts were made to grow the vegetative shoots in the nearby villages. But our attempts to grow them in the Indian Botanic garden, Sibpur were not successful.

ECOLOGY SECTION,
BOTANICAL SURVEY OF INDIA,
76, ACHARYA JAGADISH BOSE ROAD,
CALCUTTA 14,
June 4, 1973.

T. ANANDA RAO
G. C. DAS

---

[1] DAVIS, T. A. & BASU, S. K. (1969): Two cases of Bulbil bearing *Borassus flabellifer* L. *J. Indian bot. Soc. 48*:198-201.

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1974 AUGUST Vol. 71 No. 2

Observations at the dens of the dhole or Indian wild dog (*Cuon alpinus*)[1]

BY

E. R. C. Davidar
' *Canowie* ', *Coonoor*-1, *Nilgiris*

On Christmas Day 1969, my Shikari Sidda and I went looking for a hyena den in Chemmanatham in the Sigur Reserved Forest (east of the Mudumalai Wild Life Sanctuary) in the Nilgiris in Tamil Nadu when forcing our way into a thicket on the west bank of the Sigur River we found that we were in the midst of dhole burrows. Sidda went forward to the nearest earth to see if it was tenanted. It was. A very angry dhole charged him. We bolted. Fortunately it did not carry home its charge.

In the centre of the thicket it was comparatively open. I could see three dens. Later, after the dhole had vacated, I went in again and counted four. The burrows were all freshly dug and occupied an area of approximately 20′ × 15′. They were 2 to 3 feet deep, sloping at an angle of 45°. Tracks led into the thicket from different directions. The river took a wide turn at this place and one spot in particular outside the thicket commanded a fine view of the river. The dhole used this spot as a lookout point and had worn the turf down to bare earth by constant usage.

Sidda and I selected a mango tree across the river which was about 40 yards broad at this place and spent the rest of the afternoon in it. Between 25-xii-1969 and 14-ii-1970 I spent altogether six days (on 2 days from about 0700 hours until 1700 hours and on the other 4 days from 2 to 4 hours) on the tree keeping the thicket, the burrows not being visible

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[1] Accepted March 2, 1972.

from outside, under observation. That part of the jungle was elephant infested and on that score it was not possible to get to my post earlier or leave it later. On the day I tried to sit up until dusk I had a nasty experience which cured me of any desire to remain there late. A tusker came and stood under my tree, and I discovered that my perch, which I had thought was beyond an elephant's reach was not high enough and that my feet were almost resting on the bull elephant's back ! While I was contemplating my awful predicament I found another tusker making its way down to get his back also scratched.

At 0815 hrs on 26-xii-1969, four female dhole approached the thicket from my side of the river. Two of them were lactating and the other two were full grown cubs and acted like cubs of the older bitches from the previous litter. The dhole suspected my presence and tried to sniff me out. Then they lay down about 100 yards away for half an hour and watched. As I did not give myself away, their suspicion dispelled, the two older females entered the thicket, after spending a minute or so at the look-out point. The younger females made no attempt to enter the thicket and disappeared from the scene. At 12.30 a female came to the river from the thicket. Otherwise there was no activity until 1630 hours, when I left.

On 1st January 1970, an encounter with a panther enroute delayed me and it was past 0800 hours when I got to my observation post. When I neared the mango tree the dhole were walking away. Between 0830 and 0900 hours, the dhole visited the thicket thrice. There were 5 dhole this time—the two nursing mothers and the two yearling females and with them was another adult female in an advanced state of pregnancy. (The younger dogs tangled with a sounder of pigs which were ready to put up a fight but the older ones discouraged the youngsters by showing no interest. Incidentally, in spite of the presence of the dhole deer freely used that section of the river.) On the last trip only the two lactating bitches were there. There was no activity until about 1300 hours when I left.

I could not visit the dens until 19-i-1970. At 0835 two females approached the thicket, stopped at the look-out point for about 5 minutes, one of them a little longer, before entering the thicket. One of the females was limping slightly and was probably a new entrant to the colony. On 25-i-1970 I was at my post by about 0700 hours, 4 bitches came to the thicket at 0810 hours. Suspicious at the beginning, they behaved normally later. At 1020 hours and 1300 hours single females were seen coming out of the thicket. I went home after 6 hours and when I returned at 1500 hours the whole pack was hunting in the area. I saw five dhole at the look-out point and there were a dozen animals altogether. On the last day I spent at my look-out post, there was no activity, the last of the earths in use having been abandoned a few days earlier.

I tried to locate active dhole dens during the 1970/71 season, but failed. However, I was shown 2 dens which had been abandoned in the middle of the breeding season. I have come across single burrows previously and evidence of dhole vacating a burrow and digging a fresh one in a new area. A whelping female may set up a den on its own either at the outset or on quitting a common nursery.

On 4-xii-71 a cattle grazier of Moyar guided my son Peter and me to a den, where he had seen a pack of wild dogs ten days previously. The den was a deep cave under a large shelving rock and was situated in the Mudumalai Wild Life Sanctuary on the bank of a stream flowing parallel to the Moyar-Masinigudi road. It was well located on a bend and commanded a good view of both arms of the nallah. It was one of the caves I had visited the previous year shortly after it had been abandoned.

It was 1400 hours when we reached the cave. As we stood watching the entrance from across the narrow stream, a single bitch which was obviously lactating emerged growling. It was a relief when it rushed away. After sending my companions back to the car, I climbed into a tamarind tree about 25 yards to one side of the cave and sat on a bare limb of the tree after cutting and hanging a few branches to hide my perch, and waited.

At 1610 hours a female, probably the same animal which had left earlier in the afternoon returned. It sat not far from my tree and watched suspiciously for 20 minutes. Then the pack (actually a part of it as it turned out) appeared and the female entered the den. Two other dhole also went in but came out almost at once. Meanwhile a large male lay at the cave entrance and the other dhole lay about, scattered. Some 10 minutes later the female emerged and seeing the dog approached submissively whining and wagging its tail. The dog got up and ran with the bitch following till both stopped behind a screen of bamboos from where I heard the female feeding—which could only be on what the male had regurgitated. Dusk was setting and I left.

5-xii-71—I was on my perch at 0705 hours. While approaching the tree I took care not to disturb any dhole which might be in the den area. It was not until 0900 hours that the first animal arrived. It was the whelping bitch. It waited alertly changing its position every 10 minutes or so. At 0955 hours the pack came and I could see four besides the whelping bitch. The whelping bitch, after visiting the den briefly ran after a large male in a submissive attiude, wagging its tail, whining and whimpering as cubs do when trying to attract attention or soliciting food. It passed under the dog, ran pressing against its side, pushing its mouth against the side of the dog's mouth. Thereupon the dog regurgitated twice, each lump seemed to be about a kilogram in weight, which the bitch ate continuing to whimper like a cub. The same dog brought up food once more, a smaller quantity this time. The bitch repeated the act with two more dhole but these were more reluctant to oblige. She had to run chasing them up and down the stream bed for over 100 metres and pass under them frequently before they would regurgitate. One of these could have been a female.

Three dhole besides the whelping bitch entered the den briefly. From the manner in which they fumbled with the false entrance it was obvious that they were not familiar with it.

At 1015 hours a herd of domestic buffaloes ambled down the nallah grazing. The dogs joined in chasing them away from the den area. But they took a long time doing this and I expected better planning and performance from a pack of trained hunting dogs.

But for the buffaloes I would have thought that there were only 5 dhole in the pack. The herd brought 3 more within sight. Half the pack did not go too close to the den but remained 50 to 100 yards away. There were altogether 8 (4 ♂, 4 ♀). Such an equal proportion between sexes may not, however, be the rule.

By 1045 hours all the dogs had left the area and at 1050 hours the lactating bitch came back but sat outside until 1130 hours when it entered the den. It stayed inside for 10 minutes and on emerging lay at the mouth of the cave for another 10 minutes, suspiciously looking around and into trees all the time. Between 1140 hours and 1305 hours it went away and came back 4 times. But most of the time was spent in keeping vigil from its favourite look-out point among the roots of a banyan tree directly above the den.

At 1305 hours it entered the den and stayed inside for 12 minutes. When it came out it went directly to the stream and lay in the water for 5 minutes. It did not come back until 1315 hours when I, feeling sore in every limb decided to call it a day.

On my way back, I ran into the pack as they were resting lying scattered under clumps of bamboo about 100 metres off the den.

10-xii-71—I got into the tree at 0710 hours. Until 1025 there was no activity, when two dhole inspected the cave and went away. I spent a couple of hours more waiting. It was apparent that the den had been deserted. Closer inspection confirmed my suspicion.

Cubs were not seen outside the thicket or outside the cave in the latter case, even once. But tracks of cubs were seen along the river bed. It would appear that cubs are not brought out until they were ready to accompany their mothers and leave the nursery permanently.

A pregnant female was seen on 1-i-1970 and the colony was vacated around 10-ii-1970. It is probable that the dhole, when undisturbed, use the dens for about 5 weeks before abandoning them. This would also mean that the cubs were ready to accompany their mothers when 5 weeks old. There is evidence to support this assumption. On 17-i-72 a 5 week old cub was captured near my place when it strayed near the road along with other cubs, having been temporarily abandoned by the pack in the course of a hunt. Even at that age it was more used to and preferred a meat diet to milk.

In my view, the fact that no particular male was seen attending to or showed a special attachment to a particular whelping female, and the fact that more than one male brought food to a particular female coupled with the habit of breeding in colonies militates against the widely held belief of pair bond among dhole.

Peak activity took place early in the morning when most of the hunting is done.

The nursing mothers left as a pack or with the pack as the case may be to hunt very early in the morning and returned with the others between 0800 and 1000 hours depending upon their success in hunting. Thereafter they were not seen to leave or return together.

In the case first observed the pack was seen near the thicket only once. But it was evident from the alarm calls of deer that it was not far off. However in the latter instance half the pack was seen entering the den or in the immediate vicinity, and the rest within 50 to 100 metres of the den.

There was no evidence of a ' guard bitch ' as mentioned by Phythian Adams and others. If a bitch remained behind it was purely to look after her motherly duties. In the mornings, all the animals left the colony and none was left behind to ' Guard '.

Some of the adult females in the pack were not breeding. It is possible that every female in the pack did not bring up a litter every season. There appeared to be some sort of birth control among them, when their numbers were large as in the area in question.

Food-habits of water-birds of the Sundarban, 24 Parganas District, West Bengal, India—IV[1]

Stork, Teal, Moorhen and Coot

BY

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[*Continued from Vol.* **68** (3) : 716]

Anastomus oscitans (Boddaert), The Openbilled Stork

The Openbilled Stork, *Anastomus oscitans* (Boddaert), is a marsh-loving bird found around tanks, lakes, rivers and estuarine mud-flats, and also foraging nearby in paddy fields.

About the food-habits of the Openbilled Stork, Jerdon (1864, p. 766) stated : ' It lives chiefly on molluscs, especially on the large *Ampullaria* but also on various others.' He further quotes Colonel Sykes' statement that it fed on species of *Unio*. He also found that in default of its proper food, this snail-eater will eat fish, frogs, etc., but shell-fish are its special favourite. Blanford (1898, p. 378) mentioned : ' They occasionally eat fish, crabs, etc., but subsist mainly on mollusca.' Baker (1929, p. 334) writes that it feeds principally on Mollusca, chiefly the Apple-snails, land-snails, crabs and small Mollusca which it crushes first and then swallows the entire contents including the shells. It also eats worms, frogs, lizards, small snakes, insects and fishes. Ali (1955, p. 102) recorded : '. . . . soft body and viscera of . . . . [*Ampullaria* snails] form a large proportion of its food in due seasons. It also eats frogs, crabs, large insects and other small living things.'

The detailed analysis of the stomach-contents of 72 adult specimens that the author collected in the Sundarban is given in Table 14.

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[1] Accepted April 24, 1972.

TABLE 14

ANALYSIS OF THE STOMACH-CONTENTS OF THE OPENBILLED STORK

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class Reptilia				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Ptyas mucosus Linnaeus	9			Partly digested.
Xenochrophis piscator (Schneider)	5			
Total:	14	113	7·40	
Class Amphibia				
Order Anura				
Family RANIDAE				
Rana tigerina Daudin	3			Subadult.
Family BUFONIDAE				
Bufo melanostictus Schneider	8			-do-
Total:	11	39	2·55	
Series Pisces				
Class Teleostomi				
Order Ophiocephaliformes				
Family CHANNIDAE				
Channa punctata (Bloch)	4			Freshwater form. Length 30-40 mm
Order Perciformes				
Family ANABANTIDAE				
Anabas testudineus (Bloch)	10			Freshwater form. Length 30-50 mm
Miscellaneous fish fragments				Not identifiable.
Total:	14	70	4·59	
Phylum Mollusca				
Class Gastropoda				
Order Mesogastropoda				
Family PILIDAE				
Pila sp.	190			Freshwater form. Mostly soft parts.
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	6			Freshwater form. Entire animal with shell, and some soft parts with broken shells.
Family MELANIIDAE				
Melanoides sp.	8			-do-
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	17			-do-
Miscellaneous Mollusca (fragments of shells and soft parts)				Not identifiable.
Total:	221	818	53·64	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PORTUNIDAE				
Scylla serrata (Forskal)	32			Mostly the fleshy portions, with some parts of exoskeleton.
Portunus sp.	5			Mutilated specimens. Identification doubtful.
Family POTAMONIDAE				
Paratelphusa (*Barytelphusa*) *jacquemonti* (Rathbun)	11			Mostly body pulp and a few appendages.
Crustacean fragments				Not identifiable.
Total:	48	387	25·37	
Class Insecta				
Family LOCUSTIDAE				
Grasshopper (fragments)				Not identifiable.
Family TETTIGONIIDAE				
Longhorned Grasshopper (fragments)				-do-
Family GRYLLIDAE				
Crickets (fragments)				-do-
Grylloides sp.?	6+			Partly digested.
Family GRYLLOTALPIDAE				
Gryllotalpa sp.	18+			-do- Parts of body, head, legs, etc.
Order Hemiptera				
Family BELOSTOMATIDAE				
Belostoma sp.	9+			Elytra mostly.
Total:	33+	66	4·35	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheretima sp.?				In bits. Partially digested. Not identifiable.
Total:		32	2·09	

(N = Number of examples.
Weight = Total weight (in grammes) of examples of all species under a Class.
Length of fish = Its standard length.)

The food of the Openbilled Stork consists solely of animal matter comprising mainly of Mollusca (53·64%). Crustacea comes next in bulk (25·37%). The proportions of other groups are : Reptilia (snakes) 7·40%, Amphibia (Toads and frogs) 2·55%, Insects (grasshoppers and bugs) 4·35%, Oligochaeta (earthworms) 2·09% and fishes 4·59%. The fishes taken are mostly air-breathing freshwater mudfishes which venture out of water. From the contents of stomachs it is seen that the bird is mostly dependent on freshwater forms, as well as on a few land forms.

The food of the Openbilled Stork appreciably differs in wet and dry seasons. During the monsoon when the paddy-fields are inundated, it searches out *Pila* which during this season is dispersed over a great area and is found in abundance. It is then its principal food. It is interesting to note that generally it takes out the fleshy part of larger gastropods but the smaller ones are crushed and taken with the shells. The larger crabs are also appropriated in the same manner. During dry months it congregates largely on the edges of ponds and *gheries* (brackish water fish ponds) where it feeds largely on crabs, fishes, amphibia, snakes, insects, and earthworms.

Out of the 72 birds obtained from the Sundarban area, 46 were collected during the wet season (May-October) and 26 during the dry season (November-April). Analysis of their stomach contents reveals the following seasonal differences in its food-habits :

Animal groups	Wet season (food percentage)	Dry season (food percentage)
Reptilia	6	8·80
Amphibia	—	5·10
Pisces	—	9·00
Mollusca	85	22·28
Crustacea	8	42·14
Insecta	—	8·00
Oligochaeta	—	4·10

Since the Openbilled Stork feeds principally on molluscs (Gastropods) during the wet season, it is not harmful to human economics. The destruction of the snails helps the agriculturists to save their nursery crops from being nibbled and destroyed by snails. Furthermore, the spread of certain helminth parasites is also checked by the destruction of snails which are their intermediate hosts. During the dry season, however, more than half of its food is composed of fishes and crustaceans of commercial value. Its role, during this season therefore, appears to be partially adverse.

Nettapus coromandelianus coromandelianus (Gmelin), Cotton Teal

The Cotton Teal, *Nettapus coromandelianus coromandelianus* (Gmelin) is the smallest of the Indian ducks. It is a resident species in the freshwater or slightly brackish water pools of the Sundarban reclaimed area. It prefers more or less open waters having reedy borders, and plenty of aquatic vegetation and animal life. It is gregarious, and flocks of 10 to 40 are not uncommon.

Not much information is available about the food-habits of this bird. Hume & Marshall (1880, p. 104) stated: 'Their food consists of rice grain, specially the seed of wild rice known as "Pasaie" in Upper India and of the shoots of various kinds of aquatic plants, worms, water insects, and their larvae. Once or twice I have found what I believed to be the remains of minute fishes and fresh-water crustaceans in their stomachs, but of this I could not be quite certain.' Baker (1929, p. 394) reports that the Cotton Teal feeds on shoots of land and water plants, wild rice and grain and also on insects, worms, snails and small crustacea and Mollusca, though these latter form quite a small percentage of the diet. Ali (1955, p. 108) stated that the food consists chiefly of vegetable matter, also insects, crustaceans, etc.

The detailed analysis of the stomach-contents of 43 adult specimens that the author collected in the Sundarban is given in Table 15.

TABLE 15

ANALYSIS OF THE STOMACH-CONTENTS OF THE COTTON TEAL

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family Cyprinidae				
Puntius sp.	18			Length 3-5 mm. Invariably present in stomachs.
Chela sp.	32			Length 5-10 mm.
Labeo sp.?	3			Partially digested.
Family Bagridae				
Mystus vittatus (Bloch)	17			Length 10-15 mm. Some partly digested.
Order Cyprinodontiformes				
Family Cyprinodontidae				
Oryzias melastigmus (McClelland)	6			Length 5-15 mm. Freshwater form.
Fish remains				Not identifiable.
Total:	76	50	2·50	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Mollusca				
Class Gastropoda				
Order Mesogastropoda				
Family Viviparidae				
Viviparus bengalensis (Lamarck)	10			Mostly with complete shells.
Family Melaniidae				
Melanoides sp.	22			-do-
Order Basommatophora				
Family Lymnaeidae				
Lymnaea sp.	40			Some complete animals and a few crushed shells.
Family Planorbidae				
Indoplanorbis sp.	25			
Shell fragments				Not identifiable.
Total :	97	370	18·50	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family Palaemonidae				
Macrobrachium lamarrei (Milne-Edward)	16			Partly broken.
Family Alphidae				
Leander styliferus (Milne-Edward)	30			Invariably present in stomachs.
Family Atyidae				
Caridina gracilipes de Man	9			
Family Potamonidae				
Paratalphusa sp. ?	7			Parts of body and appendages.
Crustacean fragments				Not identifiable.
Total :	62	370	18·50	
Class Insecta				
Order Odonata				
Suborder Anisoptera				
Family Aeschnidae				
Aeschna sp. ?	31+			Partly digested. Identification doubtful.
Suborder Zygoptera				
Family Coenagriidae				
Ceriagrion sp.	20			
Ischneura sp. ?	10			Partly digested and broken.
Order Hemiptera				
Family Nepidae				
Laccotrephes sp.	35			
Family Gyrinidae				
Dineutus indicus Aube	13			
Family Hydrophilidae				
Hydrophilus sp.	20			
Insect fragments				Not identifiable.
Total :	129+	150	7·50	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Vegetable matter :				
Family CONVOLVULACEAE				
Ipomoea sp.				Roots and tender shoots.
Family CERATOPHYLLACEAE				
Ceratophyllum sp.				Part of plant.
Family HYDROCHARIFACEAE				
Hydrilla verticillata				
Family NAIADACEAE				
Ruppia rostellata				
Miscellaneous vegetable matter				Not identifiable.
Total :		1360	68·00	

The food of the Cotton Teal is of mixed type, composed mainly of vegetable matter (68%) with a small percentage of animal matter (32%). The vegetable matter consists of submerged and floating weeds. The major portion of animal matter consists of Mollusca (18.50%). Insects form a small proportion (7.50%) of its diet, the fare consisting mostly of naiads of dragon- and damselflies, aquatic beetles and bugs. The other animals are small freshwater shrimps (18·50%) and freshwater fish fry (standard length 3-15 mm) both of commercial value (Fig. 5).

Although the Cotton Teal consumes fishes and crustaceans of fisheries importance the percentage is so small that it cannot be considered harmful.

Gallinula chloropus indica Blyth, The Indian Moorhen

The Indian Moorhen, *Gallinula chloropus indica* Blyth, is a resident bird of the marshes. It is commonly met with in the freshwater marshes of the reclaimed area, preferring undisturbed water-reservoirs which have plenty of submerged weeds, floating vegetation, reeds and rushes growing in them and shaded by trees on their edges.

About the food-habits of the Indian Moorhen, Jerdon (1864, p. 719) records that its food is chiefly vegetable but it also takes aquatic insects, larvae and even small fish. Blanford (1896, p. 176) states that it feeds on various kinds of vegetable food and on insects. Baker (1929, p. 29) finds that its food consists of water-weeds and berries, grass-insects, snails, worms, frogs and even small fish. Ali (1955) states that its food is insects, worms, molluscs, grain and shoots of paddy and marsh plants.

Regarding another subspecies of the species, the Florida Gallinule, *Gallinula chloropus cachinnans* Bangs, Barrows (1912) states that the food consists largely of insects, chiefly aquatic. Wetmore (1916, p. 326) found that in Porto Rico, 96·75 per cent of its food was vegetable, grass and rootlets forming 90·75 per cent and the other 6 per cent consisting of seeds of grass and various weeds, much of which must have been picked up on dry land. The remaining 3·25 per cent was made up of insects and a few small molluscs. Bent (1926, p. 352) mentions that its food consists of seeds, roots, and soft parts of succulent water-plants, snails and other small molluscs, grasshoppers and various other insects and worms.

On the European subspecies, *Gallinula chloropus chloropus* (Linnaeus), Collinge (1927, p.278) who examined ten stomachs found that in Great Britain of the total food-contents 25 per cent consists of animal matter, *viz.*, 1 per cent fish remains, 1·5 per cent tadpoles, 6·5 per cent injurious insects, 1 per cent beneficial insects, 5·5 per cent neutral insects, 4 per cent slugs and snails and 5.5 per cent earthworms ; vegetable food forms 75 per cent of the total diet and consists of 55 per cent seeds and fruits of weeds, etc., 15 per cent grass and 5 per cent leaves, moss and vegetable fragment. Voous (1960, p. 86) states that its food consists of mixed animal and vegetable matters and is extremely variable, comprising a great number of marshwater insects (mosquito and their larvae), and all sorts of small water animals, seeds and fruits.

The detailed analysis of the stomach contents of 12 adult specimens of the Indian Moorhen that the author collected in the Sundarban is given in Table 16.

TABLE 16

ANALYSIS OF THE STOMACH-CONTENTS OF THE INDIAN MOORHEN

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Mollusca				
Class Gastropoda				
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	13			Some complete and a few crushed shells.
Family LITTORINIDAE				
Littorina melanostoma Gray	9			
Family HYDROBIIDAE				
Digoinostoma pulchella (Benson)	7			
Family MELANIIDAE				
Melanoides tuberculatus (Müller)	25			Invariably present in stomachs.
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	18			Partly broken. Invariably present in stomachs.
Shells in fragments				Not identifiable.
Total:	72	102	6·18	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Arthropoda				
Class Insecta				
Order Orthoptera				
Family Locustidae				
Hieroglyphus sp. ?	2			Partially digested. Identification doubtful.
Chrotogonus sp.	5			Pest of paddy crop and nurseries.
Acrotylus sp.	2			-do-
Family Tettigidae				
Acrydium sp.	2			-do-
Family Tettigonidae				
Phasgonura sp. ?	1			Partly broken and partly digested. Identification doubtful.
Miscellaneous grasshoppers (fragments)				Not identifiable.
Order Odonata				
Suborder Anisoptera				
Family Aeschnidae				
Aeschna sp. ? (Naiads)	6			Partially digested.
Anax sp. (Naiads)	1			-do-
Suborder Zygoptera				
Family Libellulidae				
Pantala sp. (Naiads)	2			
Family Coenagriidae				
Ischneura sp. (Naiads)	1			Partly digested.
Coenagrion sp. (Naiads)	3			
Miscellaneous naiads of Odonata (fragments)				Not identifiable.
Order Coleoptera				
Family Dytiscidae				
Eretes stictus Linnaeus	3			
Laccophilus sp.	1			
Family Gyrinidae				
Dineutes sp. ?	2			Partly digested. Identification doubtful.
Order Diptera				
Family Culicidae				
Larvae and Pupae (two species)	100+			Invariably present in stomachs. Partly digested. Not identifiable.
Family Chironomidae				
Larvae and pupae (one species)	20+			-do-
Insect (fragments)				-do-
Total :	151	48	2·09	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family Naididae				
Limnodrilus sp.	100+			Tangled mass.
Total :	100+	15	0·90	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Vegetable matter				
Family CONVOLVULACEAE				
Ipomoea sp.				
Family LENTIBULARIACEAE				
Utricularia sp.				Floating weed.
Family CERATOPHYLLACEAE				
Ceratophyllum sp.				Submerged weed.
Family HYDROCHARIFACEAE				
Hydrilla verticillata				Aquatic weed.
Vallisneria spiralis				-do-
Family ARACEAE				
Pistia stratiotes				Floating weed.
Family NAIADACEAE				
Ruppia sp.				Submerged weed.
Naias minor				-do-
Miscellaneous vegetable (fragments)				Not identifiable.
Total :		1485	90·00	

Of the total food consumed by the Moorhen, 90% consists of vegetable matter and 10% animal matter. The submerged or floating aquatic weeds form the chief vegetable food. The animal food consists of 2·09% insect, 6·18% freshwater molluscs and 0·90% freshwater Oligochaeta. The insect food is composed of aquatic forms, such as dragon- and damselfly naiads, aquatic beetles, larvae and pupae of mosquitoes and chironomids, and some semi-aquatic and terrestrial grasshoppers. No bugs have been found. Of the 151 examples of insects comprising 15 species, 120 examples representing three species were found to be injurious to public health, such as the mosquitoes and chironomid, and 12 examples representing five species of grasshoppers which are pests of crop and cultivated vegetables.

The Indian Moorhen, therefore, appears to be beneficial since it devours a large number of pests of crop and some disease-carrying insects.

Fulica atra atra Linnaeus, The Coot

The Coot, *Fulica atra atra* Linnaeus, is a bird of the open waters. In the Sundarban, it is usually seen in freshwater stretches which have plenty of submerged aquatic herbage skirted by reeds, sedges and bulrushes. It is generally seen in small flocks of 4 to 12 birds, and occasionally singly or in pairs. In winter, the local populations of the Sundarban are augmented by migrants from adjacent areas for food.

Regarding the Coot in India, Jerdon (1864, p. 716) states that it feeds chiefly on vegetable matter, seed and shoots of aquatic plants. Blanford (1898, p. 181) observes that the food consists of water plants, insects and Mollusca. Whistler (1928, p. 339) stated : 'Its food consists largely of vegetable matter which is taken both on the surface and by diving, but it also eats small fish, insects and mollusca, and is not above devouring the eggs and chicks of other aquatic birds.' According to Baker (1929, p. 35) it often resorts, in the mornings and evenings, to the fields to feed both on young crops and on insects, snails, worms, etc. It is also known to steal other birds' eggs and have been accused of eating their chicks. Ali (1955, p. 85) records that its food is grass and paddy shoots, aquatic weeds, and insects, molluscs, etc.

In Europe, Townsend (cited by Bent, 1926, pp. 356-357) found that its food consists of aquatic insects, molluscs, slugs, worms and small fishes, seeds, buds and tender shoots of aquatic plants. It also eats meadow grass and berries. Voous (1960, p. 87) states that its food is mixed but mainly vegetable, quantities of the submerged parts of plants obtained by diving, also seeds, fruits, buds and petals of flowers of marsh and water plants, in winter grass and in summer minute water animals.

The detailed analysis of the stomach contents of 36 adult specimens that I collected in the Sundarbans is given in Table 17.

TABLE 17

ANALYSIS OF THE STOMACH-CONTENTS OF THE COOT

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class Amphibia				
Order Anura				
Family RANIDAE				
Rana sp. (tadpoles)	27			
Rana limnocharis Boie ?	3			Partly digested.
Total:	30	50	2·81	
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family CYPRINIDAE				
Chela sp.	32			Length 10-15 mm Freshwater form. Invariably present in stomachs.
Labeo sp.	6			Length 15-25 mm Freshwater form.
Puntius sarana (Hamilton) ?	14			Freshwater form. Partly digested. Identification doubtful.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Family BAGRIDAE				
Mystus vittatus (Bloch)	7			Length 20-25 mm Freshwater form.
Order Anguilliformes				
Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	3			Length 30-50 mm Fresh and brackish water form.
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
Aplocheilus panchax (Hamilton)	2			Length 25-40 mm Freshwater form.
Total :	64	130	6·77	
Phylum Mollusca				
Class Gastropoda				
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus sp.	16			Some complete and some broken shells.
Family MELANIIDAE				
Melanoides sp.	19			Some complete shells.
Pila sp.	3			
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	35			Partly broken shells.
Family PLANORBIDAE				
Indoplanorbis sp.	22			
Broken shells				Not identifiable.
Total :	95	250	13·02	
Phylum Arthropoda				
Class Insecta				
Order Odonata				
Suborder Anisoptera				
Family AESCHNIDAE				
Anax sp. ? (naiads)	10			Aquatic.
Aeschna sp ? (naiads)	7			Aquatic.
Order Hemiptera				
Family BELOSTOMATIDAE				
Belostoma sp.	3			Aquatic form.
Family NEPIDAE				
Laccotrephes sp.	4			Aquatic form.
Order Coleoptera				
Family DYTISCIDAE				
Eretes stictus Linnaeus	17			Aquatic form.
Laccophilus sp.	26			Aquatic form.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Family Grinidae				
Dineutes indicus Aube	2			Aquatic form.
Order Diptera				
Family Culicidae				
Larvae and pupae	100+			
Total :	169	150	7·00	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family Naididae				
Limnodrilus sp.	100+			Tangled mass.
Family Megascolicidae				
Pheretima sp.	6			
Total :	106+	120	6·25	
Vegetable matter				
Family Convolvulaceae				
Ipomoea sp.				Roots and tender shoots.
Family Ceratophyllaceae				
Ceratophyllum sp.				
Family Hydrocharifaceae				
Hydrilla verticillata				
Vallisneria spiralis				
Family Graminaeae				
Oryza sativa				
Panicum sp.				
Total :		1220	63·53	

The food of the Coot consists of both vegetable matter (63.53%) and animal matter (36.47%). The vegetable matter consists of submerged and floating weeds, tender roots and shoots, grass, paddy shoots and buds, immature grains, etc. The animal matter consists of 6.25% of freshwater and land Oligochaeta (earthworm), 13.02% of freshwater gastropods, 7% of aquatic insects consisting mostly of naiads of dragon- and damselflies, mosquito larvae and pupae, aquatic Coleoptera etc.; fishes consisting of small freshwater species (standard length 10-50 mm.) of commercial value, 6.77%.

On the whole the bird does not appear to be a harmful one. The total amount of paddy shoots, grain and fishes taken is negligible, and this is largely compensated by the good it does by consuming large numbers of mosquito larvae and pupae.

(to be continued)

A list of Aphids (Homoptera : Aphididae) from India and adjacent countries[1]

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This paper presents a systematic list of the species (344) and genera (142) of aphids so far known from India and adjacent countries, namely Ceylon, Pakistan, Nepal & Sikkim and provides notes on their host plants, first reference, distribution in the region and sexual forms. The genera and species of aphids originally described from this region are also indicated. Relevant references are provided.

INTRODUCTION

Aphids are small Homoptera colonising almost all types of plants. They usually infest the stems and underside of leaves, though some species have been reported from the roots and hard woody parts. They are known to be the largest group of insect vectors for plant viruses and they also cause considerable damage by sucking the sap of the host plant; some species are well known for their role in forming plant galls. A number of species are cosmopolitian in distribution, while others have restricted distribution. Many of the tropical species reproduce by parthenogenesis, although completion of life-cycle in temperate region are known. Some species are attended by ants.

Parasites and predators of aphids have attracted considerable attention in recent times, a short résumé of which has been published by Eastop (1966).

India, with its diversity in altitude, rainfall and vegetation, resulting in tropical, sub-tropical and temperate conditions, is rich in aphids. Taxonomy of aphids was started in the last decade of the nineteenth century. Lefroy & Howlett (1909) presented for the first time a consolidated list of species known till then from India. Later Behura (1963)

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gave a similar account, in which he reported 131 species from India. These authors were apparently not aware of the exact taxonomic status of quite a number of species. Moreover, review of literature and examination of available material reveals that quite a number of species have not been incorporated even in the rather recent list of Behura (op. cit).

Since a number of researchers are now engaged in the study of the aphid fauna of India and its adjacent countries, an up-to-date list (up to 1968) of aphids from Ceylon, India, Nepal, Pakistan and Sikkim will facilitate future studies. Countries adjacent to India have been taken into account because the aphid fauna of these countries do not differ much from the Indian ones, as revealed from the works of Das (1918), Alam & Hafiz (1963), Judenko & Eastop (1963), Eastop (1966) and Hille Ris Lambers (1966).

The species numbered 21, 28, 37, 38, 56, 59, 67, 72, 92, 100, 103, 104, 110, 111, 135, 137, 138, 140, 142, 154, 155, 167, 168, 188, 210, 245, 246, 265, 280, 281, 290, 309, 310 in the text are known only from Pakistan; Nos. 25, 27, 82, 116, 119, 121, 132, 145, 147, 200, 216, 252, 277, 283, 284, 325, 331, 342 are known only from Nepal; Nos. 57, 79, 86, 95, 126, 198, 199, 219, 225, 242, 251, 261, 319 are known only from Sikkim; and Nos. 47, 88, 162, 182, 209, 229, 236, 237, 238, 240 are known only from Ceylon. These species as also the ones which are distributed in one or more adjacent countries in addition to India are denoted by abbreviations namely C—Ceylon, N—Nepal, P—Pakistan, and S—Sikkim; if there is no such abbreviation the species is then known only from India. References in the parentheses relate to the first record. The genera and species described as new from this geographical area have been marked by (**) and (*) respectively.

The British Museum Collection, London, and the Zoological Survey of India Collection, Calcutta, are abbreviated as B.M. Coll. and Z.S.I. Coll. in the text.

1 **Acyrthosiphon (Metopolophium) dirhodum** (Walk.). *Rosa* sp., (R. Kumar, B.M. Coll.).

2 **A. malvae** (Mosley). *Calceolaria* sp., (Basu 1961b).

3 **A. pisum** (Harris). *Alhagi maurosum, Clianthus dampieri, Dolichos lablab, Lathyrus odoratum, Medicago denticulata, Medicago falcatum, Medicago lupulina, Medicago sativa, Melilotus alba, Peganum harmala, Pisum sativum, Sesbania grandiflora, Trigonella foenum-graecum,* (Deshpande 1937). P

4* **A. rubi** Narz., **elliptica** Stroyan & Nagaich. *Rubus elliptica,* (Stroyan & Nagaich 1964).

5* **A. sesbaniae** David. *Sesbania grandiflora,* (David 1956a).

6 **Adelges himalayensis** Stebbing. *Abies webbiana*, *Picea morinda*, [Cotes 1896 (1893) as *Chermes abietis* L. & Kalt.; Stebbing 1904 described this species as *Chermes abietis piceae* Stebbing].

7* **A. (Dreyfusia) joshi** Schneider-Orelli & Schneider. *Abies pindrow*, (Schneider-Orelli & Schneider 1954). P

8* **A. (Dreyfusia) knuchelli** Schneider-Orelli & Schneider. *Abies pindrow*, (Schneider-Orelli & Schneider 1959), [Ghani & Rao (1966) opined that ' both these species are likely the aphids mentioned by Stebbing (1904, 1910) as *Chermes abites piciae* Stebbing and later as *Chermes himalayensis* Stebbing]. P

9* **Aiceona litseae** Basu H.R.L. *Litsea polyantha*, (Basu & H.R.L. 1968).

10* **Akkaia bengalensis** Basu, *Polygonum* sp., (Basu 1967).

11 **Aleurodaphis blumeae** van der Goot. *Cynoglossum wallichi*, [Ghosh and Raychaudhuri 1963 (1962)].

12* **Amphicercidus indicus** H.R.L. and Basu, *Lonicera glabrata*, (H.R.L. & Basu 1966).

13 **Amphorophora ampullata** Buckton. Unidentified fern (Verma 1965).

14* **A. ampullata bengalensis** H.R.L. & Basu. Various ferns (H.R.L. & Basu 1966). N

15 **Anoecia ? cornii** (Fabricius). *Cornus* to grass roots (R. Kumar, B.M. Coll.).

16 **Aphidura** sp. David. Host plant not mentioned. (David 1967).

17 **Aphis achyranthii** Theobald. *Achyranthes* sp., *Punica granatum*, (Theobald 1929).

18 **Aphis** sp. nr. **clematidis** Koch. *Clematis*, (R. Kumar, B.M. Coll.) [Later described as *Aphis clematidis simlaensis* Kumar & Burk.]

19 **A. craccivora** Koch. A large number of Leguminosae, Cucurbitaceae, Labiatae, Menispermaceae, Nyctagenaceae, Rosaceae, Scitaminaceae and Urticaceae, (Lefroy & Howlett 1909; earlier records of *Aphis medicaginis* Koch refer to this species; Basu *et al.* 1968, described the sexual forms of this species). C, P

20 **A. euonymi** Fabricius. *Benincasa cerifera*, *Centauria* sp., *Cestrum nocturnum*, *Chenopodium revely*, *Cnicus arvensis*, *Pyrus communis*, *Rumex dentatus*, *Solanum nigrum*, *Vigna catjang*,

(Lefroy & Howlett 1909 ; David 1954, opined that *fabae* Scop, *rumicis* Linne, of Indian authors, refer to this species).

21 **A. fabae** Scop. *Daucus carota*, *Malva sylvestris*, *Rumex dentata*, *Solanum nigrum*, (B.M. Coll.). P

22 **A. fabae solanella** Theo. *Solanum nigrum*, (Alam & Hafiz 1963). C

23 **A. farinosa yanagicola**, *Salix* sp., (K. D. Verma, B.M. Coll.).

24 **A. gossypii** Glover. Wide host range [Lefroy & Howlett 1909 ; Ghosh & Raychaudhuri 1964 (1962) recorded male from India]. P, S

25 **A. glycines** Mats. *Glycine max*, (K. C. Sharma, B. M. Coll. from Nepal). N

26 **A. ? hardyi** Eastop. *Psidium guajava*, (B. M. Coll.).

27 **A. kurosawai** Takahashi. *Artemisia* sp., (K. C. Sharma, B. M. Coll.). N

28* **A. longituba** H.R.L. Host plant unknown, (H.R.L. 1966 from Pakistan). P

29 **A. malvae** Koch. Compositae, Cucurbitaceae, (Lefroy & Howlett 1909, Bodenheimer & Swirski 1957 list it as synonym of *A. nasturtii* in part and *A. umbrella* Borner).

30 **A. nasturtii** (Kalt.). *Nasturtium indicum*, *Rorippa indica*, (Lefroy & Howlett 1909). P

31 **A. nerii** (B.D.F.). *Asclepias* sp., *Calotropis gigantea*, *Calotropis procera*, *Cryptostegia grandiflora*, *Cynanchum dalhousiae*, *Drega volubilis*, *Hoya longifolia*, *Hoya viridis*, *Jatropha* sp., *Marsdenia volubilis*, *Nerium odorum*, *Pergularia extensa*, (Lefroy & Howlett 1909 ; *A. asclepiadis* Pass. of many Indian authors). C, P, S

32 **A. pomi** De Geer. *Pyrus* sp., (Krishnamurti 1950).

33 **A. punicae** Passerini. *Punica granatum*, (David 1956 c ; Das's 1918, *Aphis durantii* is a synonym). P

34 **A. rubifolii** Thomas. *Rubus ellipticus*, (B.M. Coll.).

35 **A. ruborum** Borner, *Rubus fruticosus*. (B. M. Coll.).

36 **A. spiraecola** Patch. *Bidens pilosa*, *Emilia sonchifolia*, *Spirea* sp., *Mikania scandens*, *Eupatorium* sp., (Theobald 1929 ; also known as *malvoides* v.d. Goot). C, P, S

37 A. ? **umbrella** Borner. *Malvastrum* sp., (B. M. Coll.). P

38 A. ? **urticata** Fabricius. *Urtica dioica*, (B. M. Coll.). P

39 A. **verbasci** Schrank. *Buddleia paniculata*, *Polygonum atatum*, (Chowdhuri *et al.* 1968).

40 **Aphrastasia funiticta** Prey. *Tsuga brunoniana*, (B. M. Coll.).

41 **Aploneura** sp., (K. C. Sharma, B. M. Coll. from Nepal). N

42* **Asiphonella cynodonti** (Das). *Cynodon dactylon*, (George 1927 as *Geoica cynodontii*; Das 1918 as *Pemphigus cynodonti* from Pakistan). P

43** **Aspidophorodon harvensis** Verma. *Salix* sp., (Verma 1966b).

44* **Astegopteryx bambusae** (Buckton). *Bambusa arundinacea*, *Dendrocalamus giganteus*, [Buckton 1896b (1893), as *Oregma bambusae*].

45* A. **formosana** (Takahashi). *Bambusa arundinacea*, (David 1959).

46 A. **formosana neelgiriensis** David. *Bambusa* sp., (David 1958a).

47 A. **insularis** (v.d. Goot). *Dendrocalamus strictus*, (v.d. Goot 1918, from Ceylon). C

48 A. **lutecens** (v.d. Goot). *Bambusa* sp., (Basu 1961a, v.d. Goot 1918). C

49 A. **minuta** (v.d. Goot). *Bambusa* sp., (David 1959).

50* A. **mysorensis** (Theobald). *Bambusa arundinacea*, (Theobald 1929, David 1956c)

51 **Aulacorthum solani** (Kalt.). *Citrus* sp., *Digitalis purpurea*, *Solanum tuberosum*, (David 1958c)

52 A. ? **simplicois** v.d. Goot. *Acronychia pedunculata* (= *laurifolia*), (Ghosh & Raychaudhuri 1962)

53 A. **(Neomyzus) circumflexus** (Buckton). *Antirrhinum* sp., *Begonia* sp., *Calceolaria* sp., and many other glasshouse plants, (Basu & Banerjee 1958). C, S

54* A. **(Neomyzus) dicentrae** Basu. *Dicentra thalictrifolia*, (Basu 1967).

55 A. **(Neomyzus) dispersum** (v.d. Goot). *Emilia javanica*, *Emilia sonchifolia*, (David 1956d).

56 **Baizongia pistaciae** (Linn.). *Pistacia integerrima*, (Buckton 1896a, as *Pemphigus aedifactor*). P

57 **Betacallis odaiensis** Takahashi. Acanthaceae and Araliaceae, (Ghosh & Raychaudhuri (1968a), from Sikkim). S

58 **Brachycaudus helichrysi** (Kalt.). *Ageratum conyzoides*, *Blumea lacera*, *Bomarea caldasiana*, *Chrysanthemum* sp., *Cineraria* sp., *Cynoglossum furcatum*, *Erigeron canadensis*, *Prunus amygdalis*, *Prunus armeniaca*, *Prunus domesticus*, *Prunus padus*, *Prunus persica*, *Prunus sinensis*, (Das 1918, also known earlier as *B. pruni* Koch).

59 **B. (Acaudus) cardui** (L.). *Cnicus wallichi*, (Alam & Hafiz 1963). P

60 **B. (Appelia) tragopognonis** (Kalt.). Host plant unknown. (B. M. Coll.).

61 **B. (Thuleaphis) rumexicolens** Patch. *Rumex* sp., (R. Kumar, B. M. Coll.).

62****Brachymyzus jasmini** Basu. *Jasminum humile*, (Basu 1964).

63 **Brachysiphoniella montana** (v. d. Goot). *Cynodon plectostachyum*, (Das 1918, in the collection of Z.S.I. No. 8284/5/6 as *Aphis* sp.).

64* **Brachyunguis calotropicus** Menon & Pawar. *Calotropis procera*, (Menon & Pawar 1957 ; probably *Brachyunguis* sp. of Raychaudhuri & Ghosh 1959).

65****B. carthami** Das. *Carthamus oxycarpi*, *Carthamus oxycantha*, *Vernonia cinerea* and other weeds, (Fletcher 1920). P

66****B. harmalae** Das. *Peganum harmala*, (Kapur 1942). (Das 1918, reported sexual male and female from Pakistan ; Lahore). P

67****B. letsoniae** Das. *Letsonia scandens*, (Das 1918). P

68 **B. ? plotnikovi** Nevskii. *Peganum harmala*, (B. M. Coll.).

69 **B. ? tamaricis** (Lichtenstein). *Tamarix articulata*, (B. M. Coll.) P

70 **Brevicoryne brassicae** (Linnaeus). Cruciferae, (Lefroy & Howlett 1909 ; David 1958, recorded sexual female from India). P

71 **Capitophorus archangelskii** Nevskii. Host plant unknown, *Elaeagnus* elsewhere, (B. M. Coll.).

72 C. **carduinus** Walker. *Cnicus wallichii*, (Alam & Hafiz 1963). P

73 C. **eleagni** (del Guercio). *Cynara seolymus*, (David 1956d). N

74 C. **formosartimisae** (Takahashi). *Artemisia dentata*, (Basu 1961b).

75 C. **hippophaes** (Walker). *Polygonum hydropiper*, (Verma 1965).

76* C. **hippophaes indicus** Ghosh & Raychaudhuri. *Polygonum chinense*, (Ghosh & Raychaudhuri 1968).

77 C. **hippophaes javanicus** H.R.L. *Polygonum* sp., *Polygonum caespitosum*, (Basu 1961b). P

78 C. **hippophaes mittegoni** Eastop. *Polygonum glabrum*, (B. M. Coll.).

79* C. **vernoniae** Ghosh & Raychaudhuri. *Vernonia* sp., (Ghosh & Raychaudhuri, 1968 ; only from Sikkim). S

80 **Cavariella aegopdii** (Scopoli). *Salix* sp., (Verma 1965).

81* C. **nigra** Basu. *Salix eleganus*, (Basu 1964).

82 C. **salicicola** Mats. Trapped (K. C. Sharma, B. M. Coll. from Nepal). N

83 **Ceratoglyphina bambusae** v.d. Goot. *Bambusa* sp., (Basu 1961b).

84* **Cerataphis variabilis** H.R.L. *Areca catechu*, *Cocos nucifera*, (David 1959, opined that *Cerataphis* species mentioned by Lefroy and Howlett (1909) as *lataniae* Bois. is probably not *lataniae* but *variabilis*). C

85* C. **variabilis** H.R.L. unknown var. *Calamus rotang*, *Cocos* sp., (David 1959).

86 **Cerataphis** sp. *Cinchona* sp., (Cotes 1893). S

87* **Ceratopemphigiella delhiensis** Menon & Pawar. Host plant unknown, (Menon & Pawar 1958).

88* **Ceratopemphigus zehntneri** Schoutedon. *Brunfelsia uniflora*, (Doncaster 1956). C

89 **Ceratovacuna arundinariae** Takahashi. *Bambusa* sp., (B.M. Coll.).

90 C. **lanigera** Zehntner. *Saccharum officinarum*, plant of N.O. Combretaceae (Basu & Banerjee 1958). S

91 C. **orientalis** Takahashi. Host plant unknown, (B. M. Coll.).

92* **Ceruraphis eastopi** H.R.L. *Viburnum cotinifolium*, (H.R.L. 1966 from Pakistan). P

93* **Cervaphis rappardi** H.R.L. ssp. **indica** Basu. *Cajanus indicus*, (Basu 1961b).

94 **C. schoutedeniae** v.d. Goot. *Tabernaemontana divaricata*, (Krishnamurti 1930).

95 **Chaetogeoica foliodentata** Remaudiere & Tao. Alate from *Vicia faba*, [Ghosh & Raychaudhuri (1968a), from Sikkim].

96 **Chaetogeoica** sp. Host unknown, (B. M. Coll.).

97** **Chaetomyzus rhododendri** Ghosh & Raychaudhuri. *Rhododendron arboreum*, [Ghosh & Raychaudhuri 1964 (1962b)].

98 **Chaetosiphon (Pentatrichopus) fraegifoli** (Cockerell). *Rosa* sp., (David 1958a).

99 **Chaitophorus albus** Mordv. *Populus alba*, (B. M. Coll.).

100* **C. himalayensis** (Das). *Salix tetrasperma*, *Salix* sp., (Das 1918 from Pakistan). P

101* **C. kapuri** H.R.L. *Populus* sp., (H.R.L. 1966). P

102* **C. niger** Mordv. *Salix* sp., (Verma 1966).

103* **C. nigritus** H.R.L. *Salix* sp., (H.R.L. 1966, from Pakistan). P

104* **C. pakistanicus** H.R.L. *Salix tetrasperma*, *Salix* spp., (H.R.L. 1966, from Pakistan). P

105 **C. versicolor** Koch. *Populus* sp., (B.M. Coll.).

106* **Chaitoregma tattakana** H.R.L. and Basu. *Arundinaria* sp., (H.R.L. & Basu 1966).

107 **Chromaphis jugaldicola** Kalt. *Juglans regia*, (Verma 1965).

108* **Cinara eastopi** Pintera. On snow (Pintera 1965).

109* **C. indica** Verma. *Cedrus deodara*, (Verma 1966).

110* **C. lachnirostris** H.R.L. *Pinus* sp. (H.R.L. 1966, from Pakistan). P

111 **C. maculipes** H.R.L. *Pinus wallichiana* (*excelsa*), (H.R.L. 1966, from Pakistan). P

112 **C. orientalis** (Takahashi). *Pinus* sp., (S. N. Chatterjee, 1922, det. V.F.E., B. M. Coll.).

113 **C. radicicola** Well. On snow, (A. P. Kapur, Z.S.I. Coll. 1955).

114 **Cinara** sp. near **schimitscheki** Borner. *Pinus insularis*, (Ghosh & Raychaudhuri 1962 as *pineus*).

115 **Cinara (Cinaropsis)** sp. nr. **piceicola** Chol. Host plant unknown, (B. M. Coll.).

116 **Cinara (Cupressobium) tujafilina** Del Guer. From Conifers, (B. M. Coll.). N

117 **Cinara (Dinolachnus) ? abieticola** (Chol.). Underbark of *Cedrus libani* (= *deodara*), (S. N. Chatterjee 1920, B. M. Coll.).

118 **Cinara (Lachniella) comata** Doncaster. On snow, (Doncaster 1956).

119 **Coloradoa ? artimisae** Del Guercio. *Artemisia* sp., (K. C. Sharma, B. M. Coll.). N

120 **Coloradoa rufomaculata** Wilson. *Chrysanthemum* sp., (Fletcher 1920, Das 1918, as *Stephensoia lahorensis*). P

121 **C. (Lidaja) ? ? heinzei** Borner. *Artemisia* sp., (K. C. Sharma, B. M. Coll.). N

122 **Dactynotus kashmiricus** Verma. *Campanula colorata*, (Verma 1965).

123* **D. pseudotanaceti** Verma. *Helianthus tuberosus*, (Verma 1966).

124 **D. sonchi** (Geoffroy). *Carthamus tinctorius*, *Lactusa uncinata*, *Sonchus arvensis*, *Sonchus oleraceus*, (Lefroy & Howlett 1909 as *Macrosiphum*).

125 **Dactynotus** sp. Host unidentified, [Ghosh & Raychaudhuri 1964 (1962b)].

126 **Dactynotus** sp. Host unidentified, (Ghosh & Raychaudhuri in press a). S

127 **Dactynotus (Uromelan) carthami** H.R.L. *Carthamus tinctorius*, (David 1956d).

128 **D. (Uromelan) compositae** (Theobald). *Calendula* sp., *Cosmos* sp., *Zinnia* sp., etc. (Basu & Banerjee 1958).

129* **D. (Uromelan) dravidiana** David. *Vernonia cineria*, (David 1956a).

130 **D. (Uromelan) ? nigrocampanulae** (Theo.) **rapunculoides** Borner. *Centaura moschata*, *Sonchus* spp., (Z.S.I. Coll. 9598/19 leg Anandale, dt. v.d. Goot, 1915 as *M. solidaganis* Fab.).

131 **D. (Uromelan) similis** H.R.L. *Urtica dioica*, (Verma & Mathur, 1966).

132 **Diuraphis ? noxuis** Mordwilko. *Hordeum vulgare*, (B. M. Coll.). N

133 **Dysaphis emicis** Memeur. *Rumex* sp., (R. Kumar, B. M. Coll.).

134 **Dysaphis foeniculus** Theobald. *Rumex* sp., (B.M. Coll.).

135 **D. gahani** Stroyan. *Cnicus wallichii*, (B. M. Coll.). P

136 **D. ? plantaginea** (Passerini). *Malus* sp., (B. M. Coll.)

137 **D. pyri** B.D.F. *Pyrus communis*, (B. M. Coll.). P

138 **Dysaphis** sp. *Rumex dentatus*, (Alam & Hafiz 1963, from Pakistan). P

139 **Ephedrephis ephedrae** (Nevsky), *Ephedrus* sp., (Verma 1966).

140 **Epipemphigus imaicus** Chold. *Populus ciliata*, (H.R.L. 1966). P

141 **Eriosoma lanigerum** (Hausmann). *Pyrus malus*, (Cotes 1891). P

142 **E. phaenax** Mord. Alatae only in *Androchne cordifolia*, (B. M. Coll., from Pakistan). P

143 **Eriosoma** sp. Host plant unknown, (B. M. Coll.).

144 **Eucarizza elaegnus** Ferr. Host Plant unknown, (B.M. Coll.).

145 **Euceraphis ? chuansiensis** Tao. Trapped, (K. C. Sharma, B. M. Coll.). N

146 **Eulachnus thunbergi** Wilson. *Pinus insularis*, (Ghosh & Raychaudhuri in 1968b).

147 **Euthoracaphis** sp. Host plant unknown, (B. M. Coll.). N

148* **Eutrichosiphum davidi** Raychaudhuri. *Quercus serrata*, (Raychaudhuri 1956).

149 **Eutrichosiphum pasaniae** (Okajima). *Quercus coccinea*, *Quercus prinus* (*montana*), *Quercus serrata*, (David 1956d, as *lithocarpi*).

150 **E. vandergooti** Raychaudhuri. *Quercus serrata*, (Basu 1961b).

151 **Forda orientalis** George. *Pennisetum typhoideum*, *Sorghum vulgare*, (George 1927).

152 **Formosanaphis micheliae** Takahashi. *Magnolia campbellii*, *Magnolia stellata*, (Basu 1961b).

153 **Geoica lucifaga** (Zehntner). *Sorghum vulgare*, *Triticum vulgare*, (George 1924 as *Geoica* sp.).

154** **Gharesia polunini** Stroyan. *Carex* sp., (Stroyan 1963, from Pakistan). P

155** **Globulicaudaphis pakistanicus** H.R.L. *Quercus dilatata*, (H.R.L. 1966, from Pakistan). P

156 **Glyphinaphis bambusae** (v.d. Goot). *Bambusa* sp., (Basu 1961b).

157* **Greenidea artocarpi** Westwood. *Artocarpus incisa*, *Artocarpus integra*, (George 1927) C

158 **Greenidea** sp. *Dalbergia sissoo*, *Echnocarpus dorsycarpus*, (Anonymous 1956).

159 **Greenidea (Trichosiphum) anonae** (Pergande).? *Nicotiana tabacum*, (Raychaudhuri 1956).

160 **G. (Trichosiphum) ficicola** Takahashi. *Ficus* spp., (Raychaudhuri 1956).

161 **G. (Trichosiphum) formosana** (Maki). *Eugenia* sp., *Psidium guajava*, (Raychaudhuri 1956).

162 **Greenideoida ceyloniae** v.d. Goot. Trapped, (Judenko & Eastop 1963). C

163* **G. lambersi** Basu. *Hymenodictyon* sp., (Basu 1964).

164** **Hillerislambersia darjeelingi** Basu. *Lonicera* sp., (Basu 1967).

165* **Holotrichosiphon dubius**, v.d. Goot. Host plant unknown, (van der Goot 1917).

166* **Hyadaphis coriandri** (Das). *Carum carraway*, *Carum copticum*, *Coriandrum sativum*, *Cuminum sativum*, *Daucus carota*, *Foeniculum vulgare*, *Peucedanum graveolens*, (Theobald 1929 as *Hyalopterus carii* Theo. ; Das 1918 reported alate male of this species as *Brevicoryne*, from Pakistan). P

167 **Hyadaphis foeniculi** Pass. Host plant unknown (B. M. Coll.). P

168 **Hyalopterus amygdali** Blanchard. *Prunus amygdalus*, *Prunus armeniaca*, *Prunus bokhariensis*, *Prunus persica*, (B. M. Coll.). P

169 **H. atriplicis** (Linnaeus). *Chenopodium album*, *Chenopodium* spp., (Das 1918, reported it as *Brevicoryne chenopodii* (Schrank), from India (Delhi) and Pakistan (Lahore). N,P

170 **H. pruni** (Geoggroy). *Arundo donax*, *Chenopodium album*, *Coriandrum sativum* ,*Datura* sp., *Phaseolus vulgaris*, *Phragmites karka*, *Prunus americana*, *Prunus persica*, *Prunus* sp., (Fletcher 1920 ; Das 1918, reported male and female from Pakistan). P

171 **Hyperomyzus carduellinus** (Theobald). *Sonchus arvensis*, (B.M. Coll.).

172 **Hyperomyzus lactucae** Linn. *Sonchus oleraceus*, *Sonchus* spp. and also from *Ribes* spp., (B. M. Coll. ; Das 1918, recorded this species as *Rhopalosiphum* from Pakistan). P

173 **Hyperomyzus oleracea** (v.d. Goot). *Sonchus arvensis*, (David 1958b).

174 **Hysteroneura setariae** (Thomas). *Oryza sativa* and a number of Graminaceous plants, (David *et al.* 1967).

175 **Idoopterus** sp. From Fern, (A. N. Basu, W. B. Govt. Coll., Dept. Agric. Res. Inst.)

176 **Impatientinum impatiens** (Shinji). *Impatiens* sp., (Ghosh & Raychaudhuri 1968).

177** **Indiochaitophorus furcatus** Verma. *Ulmus wallachina*, (Verma 1966).

178 **Indomegoura indicum** (v.d. Goot). Unidentified host plant, (v.d. Goot 1917, as *Rhopalosiphum*).

179 **Jacksonia conandri** (Takahashi). Graminaceous host, (Ghosh & Raychaudhuri, 1968a). S

180 **Kalltenbachiella** sp. Trapped, (Judenko & Eastop 1963). C

181* **Kurisakia indica** Basu. *Engelhardtia spicata*, (Basu 1967).

182* **Lachnus greeni** v.d. Goot. *Cryptomeria* sp., (v.d. Goot 1918, from Ceylon). C

183* **L. himalayensis** v.d. Goot. Host plant unknown, (v.d. Goot 1917).

184* **L. krishni** (George). *Pyrus communis*, (George 1927 as *Dilachnus*).

185* **L. similis** v.d. Goot. Host plant unknown, (v.d. Goot 1917).

186* **L. titabarensis** Raychaudhuri & Ghosh. *Heteropnax fragnens*, (Raychaudhuri & Ghosh 1964).

187* **L. tropicalis** (v.d. Goot). Host plant unknown, (v.d. Goot 1916).

188* **Liosomaphis atra** H.R.L. *Berberis* sp., (H.R.L. 1966) (H.R.L. 1966 from Pakistan). P

189 **L. berberidis** (Kalt.). From perennials, (David 1958). C

190* **L. himalzayensis** Basu. *Berberis umbellata*, (Basu 1964). N

191 **Lipaphis crysimi** (Kalt.). Cultivated cruciferae, also fromAralaiceae, Solanaceae, (George 1927; also known as *Siphocoryne indobrasicae* Das and *Rhopalosiphum pseudobrassicae* Davis; Verma & Mathur 1966, recorded males from India). C,P

192 **L. (Lipaphisdiella) lepidii** Nevskii. *Lepidium repens*, (B. M. Coll.) C,P

193* **Longicaudus himalayensis** H.R.L. *Quercus* sp., (H.R.L. 1965).

194 **Longiunguis donacis** (Passerini). *Arundo donax*, (George 1927, as *Aphis donacis*). P

195* **L. indosacchari** David. *Iseilema laxum*, *Saccharum officinarum*, (David 1956a).

196 **Longiunguis sacchari** (Zehntner). *Saccharum officinarum* also from *Eleusine coracana*, *Panicium colonum*, *Sorghum vulgare*, and *Zea mays*, [George 1927; recorded as *Aphis sacchari* Zehnt. by early authors; Menon, (personal communication, May 5, 1968) recorded sexuales from Delhi].

197 **Macrorhinarum ensigallis** T. & T. *Ailanthus* sp., (Choudhuri *et al.* 1968; According to Tao, this species is a synonym of *Kaburagia rhusicola* Takagi var. *ensigallis* Tsai & Tang, personal communication to Dr. D. N. Raychaudhuri).

198 **Macrosiphoniella artimisae** (Boyer). *Artemesia vulgaris*, (Ghosh & Raychaudhuri 1968a, from Sikkim). S

199 **M. kikungshana** Takahashi. *Asclepias currasivica*, (Ghosh & Raychaudhuri 1968a, from Sikkim). S

200 **M. ? oblonga** Mord. *Chrysanthemum* sp., (B. M. Coll.). N

201 **M. pseudoartimisae** Shinji. *Artemisia* sp., (Verma & Mathur 1966).

202 **M. sanborni** (Gillette). *Chrysanthemum indicum, Chrysanthemum sinense, Vernonia* sp., (v.d. Goot 1917, as *Macrosiphum*). N,S

203* **M. spinipes** Basu. *Artemisia vulgaris,* (Basu 1967).

204* **M. yomogifoliae** (Shinji). *Artemisia vulgaris,* (Krishnamurti 1950 as *M. plutea* Buckton ; some authors regard this species as a subspecies of *M. artimisae*).

PART II

205 **Macrosiphum euphorbiae** (Thomas). *Chrysanthemum* sp., *Mangifera indica, Rosa* sp., (David 1958b).

206* **M. gravelli** v.d. Goot. Host plant unknown, (v.d. Goot 1917).

207 **M. hellebori** Theobald & Walton. *Agrostimma coelirosa, Echeveria* sp., *Ranunculus* sp., (David 1956a).

208 **M. jaceae** Linnaeus. *Arctotis grandiflora, Calendula* sp., *Callopsis tinctora, Cannabis sativa, Carthamus tinctorius, Corchorus olitorius, Dahlia viriabilis, Ficus religiosa, Guizotia abyssynica,* (Trehan & Halleppanawar 1949).

209* **M. minutum** v.d. Goot. *Vernonia cineria,* (v.d. Goot 1918, from Ceylon). C

210* **M. pachysiphon** H.R.L. *Rubus lasiocarpus,* (H.R.L. 1966). P

211 **M. (Sitobion) africanum** (H.R.L.) *Chrysopogon zeylanicus,* (David 1958b).

212 **M. (Sitobion) avanae** (Fabricius). *Avena sativa, Hordeum vulgare, Pennisetum typhoideum, Sorghum vulgare, Triticum vulgare, Zea mays,* (Fletcher 1920, Das 1918 ; recorded it as *Macrosiphum granarium* from India & Pakistan). N,P

213 **M. (Sitobion) fragariae** (Walker). *Chrysopogon zeylanicus, Entropogon* sp., (David 1958b).

214 **M. (Sitobion) graminis** (Takahashi). *Agapanthus umbellatus, Andropogon lividus, Bidens pilosa, Chloris barbata, Chrysopogon zeylanicus, Eragrostis gangetica, Glyceria fluitans,* (David 1958b).

215* **M. (Sitobion) indicum** Basu. *Cymbidium* sp., (Basu 1964).

216 **M. (Sitobion) ibarae** Mats. *Rosa* sp., (B.M. Coll.) N

217* **M. (Sitobion) lambersi** David. *Chloris barbata, Cynodon dactylon, Digitaria marginalis, Eremopogon foveolatus, Ischaemum aristatum, Paspalum conjugatum,* (David 1956a).

218* **M. (Sitobion) leelamaniae** David. *Eleusine coracana, Sorghum vulgare, Pennisetum typhoideum,* (David 1958c).

219 **M. (Sitobion) luteum** (Buckton). *Dendrobium densiflorum,* (Ghosh & Raychaudhuri, 1968a). S

220 **M. (Sitobion) miscanthi** (Takahashi). *Agrostis* sp., *Amphilopsis pertusa, Avena sativa, Bothriochloa insculpa, Chloris barbata, Chrysopogon zeylanicus, Cineraria* sp., *Cymbopogon martini, Dactyloctenium aegyptium, Eleusine coracana, Eragrostis superba, Hordeum vulgare, Ischaemum rugosum, Oryza sativa, Sorghum vulgare, Triticum vulgare, Zea mays,* [Theobald 1929, described this species as *Macrosiphum eleusine* and David (1956c) considered *elusine* Theobald, as subspecies of *avanae* (Fab.), Eastop (1966) opined that *elusine* Theobald seems to be a synonym of *miscanthi* Takahashi].

221 **M. (Sitobion) phyllanthi** (Takahashi). *Phyllanthus maderaspatensis, Phyllanthus niruri,* (David 1958b ; David also mentioned a subspecies of this species from *Emblica officinalis*).

222 **M. (Sitobion) rosae,** *Rosa* sp., (Basu & Banerjee 1958 ; Lefroy's (1909) record of *Siphonophora rosae*, may refer to this species or to *rosaeformis* Das ; in Z.S.I. specimens of *rosae* from Kurseong and Kumaon hills, det. B. Das 1909 were seen). C,P

223* **M. (Sitobion) rosaeformis** Das. *Rosa centofolia, Rosa damascena, Rosa moschata,* (George 1927 ; Das 1918 described this species originally from Lahore). P

224 **M. (Sitobion) smilaceti dalhousiensis** Verma. *Smilax parvifolia,* (Verma 1966).

225 **M. (Sitobion) smilacicola** Takahashi ssp. **sikkimensis** Ghosh & Raychaudhuri. *Smilax* sp., (Ghosh & Raychaudhuri 1968, from Sikkim). S

226 **M. (Sitobion) ? takahashii** Eastop. *Emblica* sp., (B. M. Coll.).

227* **Masonaphis anaphilidis** Basu. *Anaphilis triplinervis,* (Basu 1964).

228* **Matsumuraja capitophorides** H.R.L. *Rubus macilentus,* [Chowdhuri *et al.* 1968, H.R.L. (1966) described this species from Pakistan]. P

229 **Matsumuraja** sp. Host unknown, (Judenko & Eastop 1963). C

230 **Melanaphis bambusae** (Fullaway). *Bambusa* sp., (Basu 1961b).

231 **Melanaphis ? pahalensis** Takahashi. Plant of N.O. Combretaceae, (Ghosh Coll. 1962). S

232 **Metaphordon polygoni** (v.d. Goot). *Nicotiana tabacum*, probably a migrant, [Ghosh & Raychaudhuri 1968a]. S

233 **Microlophium ?? evansi** (Theobald). *Urtica* sp., (Verma, B. M. Coll.).

234** **Micromyzodium filicum** David. *Gymnograma peruviana*, *Neprolepeds* sp., *Polypodium* sp., (David 1958d).

235 **M. dasi** Verma. From unidentified fern, (Verma 1966).

236 **Micromyzus dispersum** v.d.G. *Emilia* sp., (B. M. Coll.). C

237 **M. eastopi** Carver. Host plant unknown, (Carver 1965). C

238 **M. judenkoi** Carver. Host plant unknown, (Carver 1965) [Probably last two are same species recorded by Judenko & Eastop 1963 as *Micromyzus* spp.]. C

239* **M. kalimpongensis** Basu. *Hedychium coronarium*, (Basu 1967).

240* **M. nigrum** v.d.G., *Cinnamomum* sp., (v.d.G. 1918 from Ceylon). C

241 **Mindarus japonicus** Tak. *Abies pindrow*, (B. M. Coll.).

242 **Mollitrichosiphum tenuicorpus** (Okajima). *Castanospermum* sp., [Ghosh & Raychaudhuri 1968 (a), from Sikkim]. S

243* **M. (Metatrichosiphon) nandii** Basu. *Alnus nepalensis*, (Basu 1964).

244 **Mordvilkomemor** sp. *Artemisia vestata*, (Choudhuri *et al.* 1968).

245 **Mordvilkomemor** sp. *Cnicus wallichii*, (Alam & Hafiz 1963). P

246 **Myzaphis rosarum** (Lltb.). *Rosa* sp., (B. M. Coll.). P

247 **Myzocallis bambusifoliae** (Takahashi). *Phyllostacus manii* (Ghosh & Raychaudhuri 1962a).

248* **M. flooribundi** Verma. *Quercus floribunda*, (Verma 1965).

249 **M. kahawalokalani** Kirkaldy. *Lagerstroemia* sp., *Lawsonia alba*, (Anonymous 1956).

250 **Myzus cerasi** Fabricius. *Rubus* sp., (R. Kumar, B. M. Coll.).

251 **M. dycei** Carver. *Glycine max*, probably a migrant, (Ghosh & Raychaudhuri 1968a, from Sikkim). S

252 **M. formosana** Takahashi. *Polygonum* sp., (B. M. Coll.). N

253 **M. ? hemerocallis** Takahashi. *Agapanthus umbellata*, *Hemerocallis fulva* (David 1956d).

254 **M. ? geranicola** Shinji. *Geranium* sp., (K. D. Verma, B. M. Coll.; According to Takahashi 1965, *M. geranicola*, Shinji 1935 is not a *Myzus*).

255 **M. ornatus** Laing. *Cineraria* sp., *Duranta plumieri*, (David 1956d). C

256 **M. (Nectarosiphon) persicae** (Sulzer) Extremely polyphagous species, [Barlow 1896, as *Rhopalosiphum dianthi*; Ghosh & Raychaudhuri 1962c, recorded male and Menon 1968 (personal communication), recorded female from Delhi]. C,P,S

257* **M. (Prunomyzus)** sp. *Prunus cerasoides*, (Choudhuri *et al.* 1968).

258 **M. (Sciamyzus) ascolonicus** Doncaster. *Fragaria* sp., *Plectranthus coetsa*, (Choudhuri *et al.* 1968)

259* **Nasonovia jammuansis** Verma, *Delphinium* sp., (Verma 1965; B. M. Coll. includes a species *Kakimia* n.sp. Verma, which is this species according to Dr. Verma, in personal communication).

260** **Neobetulaphis pusilla** Basu. *Betula utilis*, (Basu 1964).

261** **Neorhopalosiphoninus smilacifoliae** Ghosh & Raychaudhuri. *Smilax* sp., (Ghosh & Raychaudhuri, 1968a, from Sikkim). S

262* **Nippolachnus bengalensis** Basu. *Eriobotrya dubia*, (Basu & H.R.L. 1968).

263* **N. erybotryae** Basu & H.R.L. *Eriobotrya petiolata*, (Basu & H.R.L. 1968).

264 **N. pyri** Matsumara. *Pyrus insularis* (= *khasya*), [Ghosh & Raychaudhuri 1963 (1962)].

265 **Obtusicaudus** sp. *Artemisia* sp., (B. M. Coll.). P

266* **Oedisiphum soureni** Basu. *Anaphilis triplinervis*, (Basu 1964).

267 **Ovatus crataegarius** (Walker). *Mentha* sp., (Verma 1965). P

268 **Panaphis juglandis** (Goetze). from *Juglans regia*, (Verma 1965).

269****Paracallipterus kalipadi** Raychaudhuri & Ghosh. *Anona squamosa*, (Raychaudhuri & Ghosh 1964).

270 **Paratrichosiphum alnicola** Basu. *Alnus nepalensis* (Basu 1967).

271* **P. minutum** (v.d. Goot), Host plant unknown, (v.d. Goot 1917), (Raychaudhuri 1956).

272 **P. tattakanum** (Takahashi). *Quercus* sp. (Basu 1961b).

273* **P. tattakanum assamensis** Ghosh & Raychaudhuri. *Quercus* sp., (Ghosh & Raychaudhuri 1962b.).

274****Paratrichosiphum** sp. *Solanum nigrum*, (Raychaudhuri 1956, reported sexual female).

275****P. (Neoparatrichosiphum) khasyanum** Ghosh & Raychaudhuri. *Quercus* sp., [Ghosh & Raychaudhuri 1964 (1962)].

276* **Pemphigus lichtenstani** Tullgren. *Populus* sp., *Populus nigra*, (Buckton 1897, as *immunis*).

277 **P. ? mordwilkoi** Chol. *Populus ciliata*, (B. M. Coll.). N

278* **P. napaeus** Buckton. *Populus* sp., (Buckton 1897).
Note.—**Pemphigus cinchonae** Buckton, from *Cinchona* sp. [Cotes 1893 (1892), is not an aphid, but an aleyrodid, according to V. F. Eastop].

279 **Pentalonia nigronervosa** Coquerel. *Alocasia macrorhiza*, *Caladium* sp., *Calocasia antiquorum*, *Elettaria cardamomum*, *Musa paradisica* and various *Musa* spp., (George 1927). C

280 **Periphyllus vandenboschii** H.R.L. *Acer* sp., (H.R.L. 1966 from Pakistan). P

281 **Phorodon (Diphorodon) cannabis** Passerini. *Artemisia* sp., *Cannabis indica*, *Cnicus arvensis*, *Cnicus* sp., (Das 1918). P

282 **Pineus laevis** (Maskell). *Pinus* spp., (Eastop 1966 mentioned its probable distribution in Pakistan).

283 **P. pini** Macquart. *Pinus excelsa*, (B. M. Coll.). N

284 **Pleotrichophorus ? chrysanthemii** (Theobald). Host plant unknown, (B. M. Coll.). N

285 **Prociphilus micheliae** H.R.L. *Michella champaca*, (HRL 1933).

286 **P. oriens** Mord. Host plant unknown, (B.M. Coll.).

287 **P. osmanthae** Essig & Kuwana. Host plant unknown, (Ghosh & Raychaudhuri 1968b).

288 **Prociphilus** sp. *Tsuga brunoniana*, (Basu 1961 b).

289* **Protrama penecaeca** Stroyan. *Helianthus tuberosus*, (Stroyan 1964 ; Verma & Mathur 1966, recorded male of this species).

290 **Pseudoessigella brachycheata** H.R.L. *Pinus wallichiana*, (H.R.L. 1966 from Pakistan). P

291 **Pseudoregma bambusicola** (Takahashi). *Bambusa* sp., (Puttarudriah & Chennabasavanna 1952 as *Oregma*).

292 **P. panicola** (Takahashi). *Oplismenus compositus*, (David 1959 as *Oregma*).

293 **Pterochloides persicae** (Chol.). *Prunus amygdalis*, *Prunus armenica*, *Prunus bokhariensis*, *Prunus communis*, *Prunus persica*, *Prunus* spp., (Fletcher 1920 ; Das 1918, described it as *Tuberodryobius persicae* Cholod & also recorded sexual female). P

294 **Pterocomma pilosa** Buckton. *Salix* sp., (Verma 1965).

295 **P. populea** Kaltenbach. Host plant unknown, (v.d. Goot 1917).

296** **Pyrolachnus pyri** (Buckton). *Pyrus* sp., (Buckton 1899 a, as *Lachnus*).

297 **Reticulaphis ? shiiae** Tak. Host plant unknown, (B. M. Coll.).

298 **Rhodobium porosum** (Sanderson). *Rosa* spp., (Krishnamurti 1930, as *Macrosiphum rosaefolium* Theo.).

299 **Rhopalosiphoninus latisiphon** Davidson. sprouts of *Solanum tuberosum* (David 1954b).

300 **Rhopalosiphum maidis** (Fitch). Collected from many host plants, mainly of N. O. Graminae, [Lefroy 1909 ; Das 1918 recorded alate male from Pakistan ; Menon 1968, (personal communication), collected oviparous female from Delhi]. C,N,P

301 **R. nymphaeae** (Linnaeus). *Aponogeton moncharias*, *Eichhornia speciosa* (*crassipes*), *Lemna* sp., *Nelumbia speciosum*, *Prunus persica*, *Scripus lacustris*, *Vallisneria spiralis* also from plants of Cactaceae, & Leguminosae, (Lefroy 1909 ; Das 1918 and David 1958b, collected males of the species from Pakistan & India). P

302 **Rhopalosiphum padi** Linnaeus. *Avena sativa, Panicum crusgalli, Triticum vulgare, Zea mays,* (v.d.Goot 1917 as *Siphonaphis padi* L.) probably *Siphocoryne avcnae* (Fabr.) of Das 1918. N,P

303 **Rhopalosiphum rufiabdominalis** (Sasaki). Wide host range but mostly on Graminae, (Das 1918, as *Siphocoryne avenae & Aphis* sp., as seen in the collection of Z.S.I.). C,P

304* **R. vagans** v.d. Goot. Host plant unknown, (v.d. Goot 1917, probably belongs to *Sinomegoura, Meguroparsus* group of genera).

Note.—Rhizobius jujubae Buckton, recorded from *Zizyphus jujuba* by Buckton 1899b, is not an aphid, but a coccid.

305 **Saltusaphis scripus** Theobald. Host plant unknown, (Menon & Pawar 1958 as *S. africana* Eastop).

306 **Schizaphis cyperi** (v.d. Goot). *Cyperus rotundus.* (Das 1918 as *Toxoptera*). C,P

307 **S. graminum** (Rondani). *Avena sativa, Cynodon dactylon, Cyperus niveus, Cyperus rotundus, Eleusine coracana, Hordeum vulgare, Sorghum vulgare, Triticum sativum, Triticum vulgare,* (George 1927 as *Toxoptera graminum*). C,P

308 **S. minuta** v.d.G. *Cyperus rotundus,* (Eastop 1966).

309 **S. ? ? pilepes** Oss. Host plant unknown, (B.M. Coll.). P

310 **S. pyricola** Mats. *Pyrus communis,* (Das 1918, as *Toxoptera punjabipyri* Das from Pakistan). P

311 **S. ? ? pyri** Shapsnikov. *Pyrus* sp., (B. M. Coll.).

312 **Schoutedenia bougainvilliae** (Theobald). *Emblica officinalis,* (George 1927, as *Setaphis bougainvilliae* Theobald ; *S. emblica* Patel & Kulkarni & *S. emblica andhraka* David & Lambers 1956b, are considered synonyms of this species by Ghosh & Raychaudhuri 1962 ; David 1956b recorded sexual forms of this species.

313 **Schoutedina lutea** (v.d.Goot.). *Boehmeria polystachya,* (Basu 1961b). C

314 **Semiaphis** sp. *Lonicera angustifolia,* (Chowdhuri *et al.* 1968).

315 **Shinjia pteridifoliae** Shinji. *Dryopteris* sp., (Ghosh, Coll. 1962). N

316** **Shivaphis celti** Das. *Celtis australis, Celtis tetrandra* var. *hamiltonii,* (Das 1918 ; also described sexual forms). C,P

317 **Sinomegoura citricola** (v.d. Goot). *Citrus reticulata, Litsea polyantha, Photinia integrifolia,* migrant on *Bambusa* sp., (Basu 1961b, recorded it as *Ayrtchosiphon citricola*). S

318* **S. pyri** Ghosh & Raychaudhuri. *Pyrus communis,* (Ghosh & Raychaudhuri 1968b).

319 **S. rhododendri** Takahashi. Migrant from *Smilax* sp., (Ghosh & Raychaudhuri 1968a, from Sikkim). S

320 **Sipha (Rungsia) maydis** Pass. From Grass, (B. M. Coll.).

321 **Smynthurodes betae** Westwood. Roots of Compositae, (Basu 1961b).

322* **S. gossypii** Kulkarny. Roots of *Gossypium* sp., (Kulkarny 1956 as *Trifidaphis*).

323* **Stomaphis mordwilkoi** H.R.L. From Walnut, (H.R.L. 1933).

324****Subovatomyzus leucoscephtri** Basu. *Leucosceptrum canum,* (Basu 1964).

325* **Sumatraphis ? celti** Tak. Trapped, (K. C. Sharma, B. M. Coll.). N

326* **Tetraneura heterohirsuta** Carver & Basu. *Imperata arundinacea,* (Carver & Basu 1961).

327 **T. javensis** v. d. Goot. *Saccharum officinarum,* (George 1927, as *T. cynodontis coimbatorensis* George, according to David 1958c).

328 **T. nigriabdominalis** (Sasaki). Roots of various Graminae including *Oryza sativa,* [Fletcher 1914 as *T. ulmi* De Guer, according to David 1954a, who recorded it as *T. hirsuta* Baker, which is a synonym of *T. nigrabdominalis* (Sasaki)]. C,P,S

329 **T. yezoensis** Mats. From Grass roots, (B. M. Coll.).

330 **Therioaphis trifolii** (Monell). *Cyperus rotundus, Medicago lupalina, Medicago sativa,* (Buckton 1899b as *Chaitophorus maculatum* Buckton).

331 **Tiliaphis** sp. Host plant unknown, (B. M. Coll.). N

332 **Titanosiphon bellicosum** Nevskii. *Artemisia skoparia,* (B. M. Coll.). P

333 **Toxoptera aurantii** (Fonscolombe). *Acalypha* sp., *Albizzia odoratissima, Anona squamosa, Artocarpus* spp., *Bougainvillea spectabilis, Caesalpinia cariaria, Camellia* spp., *Citrus* spp., *Coffea*

arabica, *Combretum* sp., *Dalbergia sissoo*, *Echites rubrovenosa*, *Gordinia obtusa*, *Ixora* sp., *Litchi sinensis*, *Litsea* spp., *Piper* sp., *Macleania punctata*, *Mangifera indica*, *Moringa oleifera*, *Photina japonia*, *Saccharum officinarum*, *Santalum album*, *Schima wallichi*, *Tamarindus indicus*, *Theobroma cacao*, etc, [Cotes 1896 (1893) as *Ceylonia thaecola*, Buckton]. C,S

334 **T. citricidus** (Kirkaldy). *Artocarpus incisa*, *Citrus* spp., (George 1927, as *Aphis tavahsi* Del Guercio). C,N

335 **T. odioae** (v.d. Goot). *Anacardium occidentale*, *Achras sapota*, *Hamelia patens*, *Hibiscus rosasinensis*, *Mangifera indica*, *Odina* sp., *Panex* sp., *Vibrunum foetidum*, (George 1927 as *Aphis odinae* v. d. Goot ; *Longiunguis spathodeae* v.d.G. is probably a synonym according to Judenko & Eastop 1963).

336* **Tricaudatus polygoni** Narz. s.sp. **tuberculatus** H.R.L. & Basu. *Spirea corymbosa*, (H.R.L. & Basu 1966).

337* **Trichaitophorus recurvispinosus** H.R.L. & Basu. *Actinidia callosa*, (H.R.L. & Basu 1966).

338 **Trichosiphoniella ? momonis** Mats. *Prunus cerasoides*, (B.M. Coll.).

339* **Tuberoaphis hydrangeae** Tseng & Tao, s.sp. **digitata** H.R.L. & Basu. *Hydrangea robusta*, (H.R.L. & Basu 1966).

340 **Tuberolachnus saligna** (Gmelin). *Salix aegyptica*, *Salix babylonica*, *Salix tetrasperma*, (Ghosh & Raychaudhuri 1962a, Das 1918, as *T. viminalis*).

341* **Unipterus** n. sp. Host plant not mentioned, (David 1967).

342 **Vesiculaphis ? caricis** (Tull.) Trapped, (K. C. Sharma, B. M. Coll.). N

343 **V. grandis** Basu. *Rhododendron* sp., (Basu 1964).

344* **V. pieridis** Basu. *Pieris ovalifolia*, (Basu 1964).

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On the Specificity of Madras Backwater Oyster *Crassostrea madrasensis* Preston and the American Oyster *Crassostrea virginica* Gmelin[1]

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(*With two text-figures*)

Several conchological and malacological characters were studied in two oysters *viz.*, *Crassostrea madrasensis* Preston and *Crassostrea virginica* Gmelin, to find out whether they are synonymous as indicated by earlier workers. The studies indicate that these are two distinct species though apparently of close similarity.

INTRODUCTION

Whatever little is known about the systematics of oysters of the Indian coast is confusing. Recently the author (Durve 1967) attempted to clarify this confusion and place the two well-known backwater oysters of India into two distinct species namely *Crassostrea madrasensis* Preston and *Crassostrea gryphoides* (Schlotheim). However, this work does not clarify the position of *C. madrasensis* as a synonym of the American oyster *C. virginica* Gmelin, as opined by Vredenburg and reported by Annandale and Kemp (1916) and also by Hornell (1918, 1949 and 1951).

Preston (1916) had, of course, observed the close similarity between *C. madrasensis* and *C. virginica* (=*Ostrea canadensis* LK.) but noted that the Indian backwater oyster (*C. madrasensis*) is of a straighter form and thinner texture and is much foliaceous externally. The left valve is more concave and the inner margins of both valves as well as the muscular scars are of a dark purple colour. He thus considered the Madras oyster as a distinct species namely *O.* (*C.*) *madrasensis*. Gravely (1941) and Satyamurthi (1955) supported the identification by Preston. In view of this controversy, it was felt desirable to study the conchological and mala-

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cological characters of *C. madrasensis* and *C. virginica* to establish the correct identity of the former.

A sample of *C. virginica* was obtained from the U.S. Shellfish Advisory Service. The soft parts of this sample of 4 medium-sized oysters were received preserved in Davidson's fixative while their shells came dry, cleaned and properly numbered. Though the sample was small, there is a considerable literature available on this oyster which could be profitably used for the present study. A sample of twelve specimens of *C. madrasensis* from Ennore backwaters near Madras was obtained from the Southern Regional Station of the Zoological Survey of India. In all 28 different characters both from the shell and soft parts of *C. madrasensis* and *C. virginica* were studied and compared. All the measurements reported in this paper have been taken by a vernier calliper and fine mathematical divider.

Observations and Remarks

There is a diversity of opinion regarding the validity of any character in a highly variable form like an oyster. It is well known that the so-called diagnostic characters of oysters undergo considerable changes due to the environment; with the result, at times, the same species passes under several names. However, recently, there have been attempts to standardize these characters. In spite of this, the so-called generally constant characters do show deviations. For instance, the deep cup-shaped nature of the left (lower) valve has been generally reckoned as a diagnostic character ; but the author has seen this being altered due to the environment such as bottom contour, surf beaten coast-line with exposed or semi-exposed rocks etc. Galtsoff (1964) states ' size, shape, curvature and proportion of the beak *i.e.*, the pointed (dorsal) end of an oyster shell, are useful generic characters, but like other parts of the shell they are variable and cannot be entirely depended upon for identification.' He also states ' the position of the muscle scar and its outline differs in various species and therefore, is used as a taxonomic character.' But, records considerable variations in the scar shapes in the individuals of the same species *i.e.*, *C. virginica.* The author has also observed differences in the scar-shapes in the specimens collected from the same locality but different substrata. However, it is felt that the scars in general may show some constancy in shape which could perhaps be specific.

Thomson (1954) and Galtsoff (op. cit.) observed that the soft anatomy of the oyster is not very variable but its taxonomic usefulness is limited. However, Thomson found several characters of the soft anatomy useful in his work on Australian oysters. The usefulness of the different conchological and malacological characters in the classification of oysters has been well discussed by Thomson and Galtsoff. So far as the oysters of the present investigation are concerned, it was possible to separate some characters out of 28 examined ; which showed appreciable differences leading to the understanding of the species.

The following characters were found to differ appreciably in *C. virginica* and *C. madrasensis* though in the case of some characters there was slight similarity in a few individuals.

Conchological characters

1. External sculpture on the right (upper) valve.
2. Coloration of the external surface of the shell.
3. Internal coloration of the shell-valves.
4. The recess below the beak of the left (lower) valve and its depth.
5. The shape and colour of the muscle-scar.
6. The width and depth of the hinge-area (beak) groove in the lower valve.
7. The colour of hinge ligament.

Malacological characters

1. The shape of adductor muscle.
2. The position of anal opening in relation to the adductor muscle.
3. The nature of anal opening.

These characters are dealt with separately below.

CONCHOLOGICAL CHARACTERS

1. *External sculpture on the right* (*upper*) *valve :*

The sculpture of the shell is a greatly variable character depending on local conditions. In oysters of the present study, it was found that *C. madrasensis* was much more foliaceous externally than *C. virginica*. The extent of growth fringes in both the species varied considerably in different specimens. The comparison of the external sculpture of *C. virginica* when made with *C. madrasensis* collected from Athankarai estuary near Mandapam also confirmed the earlier inference. Galtsoff (1964) states that the external sculpture in the American oyster varies greatly and supports this by a few figures of this oyster collected from different localities on the coast of America.

2. *Coloration of the external surface of the shell :*

While no taxonomic significance is attached by Galtsoff (op. cit.) to the external coloration, Thomson (op. cit.) states, ' For each species there is a range of pigment patterns and a range of shades of colour from which specimens do not vary though they may overlap the range of another species.' Iredale (1939) attempted to use coloration for taxonomic purpose.

In the case of *C. madrasensis*, the pattern of coloration ranged from one uniform colour to the various mixtures of 3-4 different colours, patches of one or more colours to their localization on different portions of the surface. In the case of *C. madrasensis*, the normal colours are purple, white, brown and their various shades. The white colour is invariably restricted to the top surface of the right valve and also the sides of the left valve which may be due to the bleaching of this portion by sunlight in the case of exposed or semi-exposed specimens. The purple colour is generally in the form of suffusion and at times in patches or streaks. The brown colour is invariably restricted to the growth fringes.

In *C. virginica*, white and brown or blackish-brown colours are predominant. The purplish shade is slight and is obliterated by blackish-brown shade. Sides of the lower valve are white with brownish and purple shades.

3. *Internal coloration of the shell-valves :*

Internal coloration, according to Thomson (op. cit.), is specifically constant. He feels that there may be only one colour or ranges of a few shades characteristic of each species.

In *C. madrasensis* the internal coloration is white but almost always it has purple around the whole or part of the margin. This coloration is absent in the middle portion of both the valves and also near the hinge region. The coloration ranges from light pink-purple and deep purple to almost black. The deeper colour is invariably restricted to the ventral margin facing the posterior portion of the gill, especially in the case of the lower valve. The purple coloration is generally about 5 to 10 mm inside from the edge of the shell. Thus a strip of 5 to 10 mm left towards the edge is almost invariably pure white and nacreous. The purple coloration of the margin appears to be a constant feature of this species as it was also noticed in the case of specimens collected from Athankarai estuary near Mandapam.

In the case of *C. virginica*, the internal coloration is pure white or nacreous white with yellowish patches here and there only in some specimens.

4. *The recess below the beak of the left (lower) valve and its depth :*

The recess below the hinge of the lower valve has been known to be of taxonomic value. In *C. madrasensis*, the recess beneath the beak is invariably very well developed. In specimens examined for the present study, it ranged from 2 to 10 mm in depth. Individuals having the recess depth of more than 2 mm were in majority. In *C. virginica* the maximum depth of the recess recorded in the sample received from U.S.A. was 4·00 mm and the minimum was 1·00 mm.

5. *The shape and colour of the muscle scar :*

The shape and colour of the adductor impression varies with species. There is a variation even in the individuals of the same species. However, the general shape and coloration could be regarded as more or less constant for any species. In *C. madrasensis*, the shape of the scar varies with the individual but is either elliptical, transversely broad or oblong ; the last two being more or less overlapping. In case the scar is roundish in any specimen, its one end will invariably taper to a blunt point. Only in rare cases a broad bean-shaped scar occurs. Its colour is always more or less deep black. No light bands or patches have so far been noticed by the author on the scar.

On the other hand, the shape of the scar in the case of *C. virginica* is almost roundish, somewhat bean-shaped with the dorsal margin of the scar having slight concavity in the centre. The differences in the dimensions of the scars from both the valves in these two oysters are thus obvious. Galtsoff (op. cit.) however states that the shape of the muscle scar in *C. virginica* is a variable character and to some extent reflects the shape of the shell. The colour of the scar in *C. virginica* is light to deep purple but never deep black as in *C. madrasensis*. The colour may be uniformly purple or deep purple bands may alternate with lighter bands. At times, the colour is splotched with lighter sprinklings.

6. *The width and depth of the hinge area groove in the lower valve :*

From the casual observation of the shells of *C. madrasensis* and *C. virginica*, it was felt that the groove in the centre of the beak or hinge area is narrow and shallow in the case of the former. When the actual measurements were taken it was found that narrowness of the hinge area groove is not specific. However, its depth though could not be measured, appeared to be constantly more in the case of *C. virginica* when compared with that of *C. madrasensis*.

7. *The colour of hinge ligament :*

The significance of the ligament in the systematics of bivalves in general has been studied by Bowerbank (1844), Jackson (1890, 1891), Dall (1889, 1895), Biedermann (1902) and others. The entire work in this direction has been well reviewed by Haas (1935). Recently, Thomson (op. cit.) made use of this character to separate two well-known Australian oysters namely *C. commercialis* and *C. tuberculata*. Galtsoff (1964) makes no mention of the significance of this character in the taxonomy of oysters.

In the case of *C. madrasensis*, the colour of the ligament was observed to be invariably black at two ends but brown in the central bulging portion. However, slight variations were also noticed in some oysters. In *C. virginica*, the ligament was found to be black in all the specimens of the sample except one, where it was brownish-black in the central bulging portion. This character may perhaps prove to be of significance so far as the systematics of these two oysters is concerned.

MALACOLOGICAL CHARACTERS

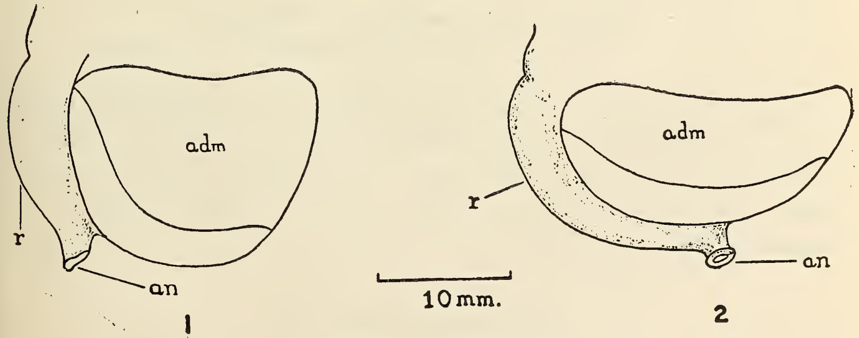
8. *The shape of the adductor muscle :*

The adductor muscle does not have the taxonomic significance. Thomson (op. cit.) used the relative proportions of the catch and quick areas of this muscle for the separation of genera. However, Hopkins (1930) has reported that this ratio of catch and quick areas with each other depends on ecological conditions.

The shape of the adductor muscle was found to be more or less constant in two species of oysters studied for this investigation. It was either elliptical or oblong in the case of *C. madrasensis* and almost round—slightly flat and concaved on the dorsal margin, in the case of *C. virginica*.

9. *The position of anal opening in relation to adductor muscle :*

This feature was found to differ in the two oysters under investigation. Along with the position of the anal opening, the size of the rectum differs. It was noticed that the size of the rectum (from the dorsal margin of the adductor to the anal opening) is more in the case of *C. madrasensis* than in *C. virginica* except in one or two specimens. The position of the anus also differs. In *C. madrasensis*, the opening is always invariably situated about the middle of the ventral margin of the adductor muscle while in *C. virginica*, it is at the corner of the posterior and ventral margins of the adductor (Fig. 1). This character has not so far been used in the systematics of oysters.



C. Virginica   *C. madrasensis*

Fig. 1. Anal opening in relation to adductor muscle.
r—Rectum ; adm—Adductor muscle ; an—Anus.

10. *The nature of anal opening :*

This character appeared to be strikingly different in the two oysters *viz.*, *C. madrasensis* and *C. virginica*. In the case of former, the opening is not simple. The wall of the anus is extra-ordinarily thickened and turned backwards forming a sort of collar to the anal opening. This collar is thinner at one end of the anal opening forming a small notch (Fig. 2). This collar is not always tightly folded but at times is loose and lessens in width at one end giving an appearance of a valve-like structure attached to the anus. The collar was noticed to have folds and lobed appearance in two specimens. The three varieties of collars observed in the sample of 12 specimens of *C. madrasensis* have been figured in Fig. 2. Only in one individual the anus was observed to be simple. In the case of *C. virginica*, the anus is simple, without any collar. This character has also not so far been used in the systematics of oysters.

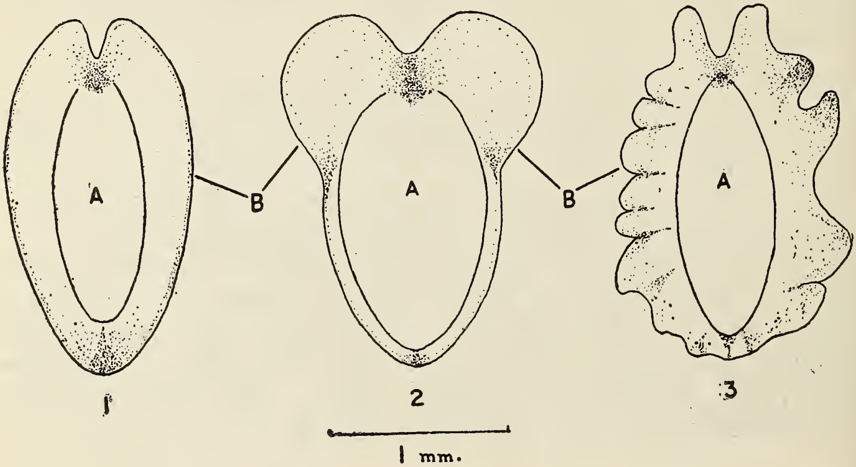


Fig. 2. Anal opening in *C. madrasensis*.
A—Anal opening ; B—Collar.

From the account given above, it could be noticed that the two oysters *viz.*, *C. madrasensis* and *C. virginica* which were earlier considered as synonymous by some workers have several striking differences which could separate them into two distinct species. These differences have been tabulated below.

CONCHOLOGICAL CHARACTERS

	C. madrasensis	*C. virginica*
1.	More foliaceous externally.	Less foliaceous externally.
2.	More variously coloured externally.	Less coloured externally.

3. Purple suffusion or streak around the internal margins and especially in the region opposite the posterior portion of the gills.	Internal surface pure white.
4. The recess beneath the hinge area (beak) in the lower valve invariably very well-developed.	The recess not very well-developed.
5. The shape of the muscle scar is generally elliptical or oblong.	The shape of the muscle scar generally reniform (bean-shaped) or even roundish.
6. Colour of the muscle scar almost deep black.	Colour of the muscle scar ranges from light to deep purple but never deep black.
7. The central groove of the hinge area shallow.	The central groove of the hinge area comparatively deep.
8. Colour of the ligament is black at sides but brown in the central bulging portion.	Colour of the ligament is generally black throughout.

MALACOLOGICAL CHARACTERS

9. The adductor muscle is either elliptical or oblong.	The adductor muscle is either roundish or bean-shaped.
10. The size of rectum generally large.	The size of rectum generally small.
11 Anal opening situated about the middle of the ventral margin of the adductor muscle.	Anal opening situated at the corner of the posterior and ventral margins of the adductor muscle.

In view of the above differences in two oysters *viz.*, *C. madrasensis* and *C. virginica*, the description of the former given by the author (Durve 1967) could be slightly amended in respect of the development of the recess beneath the hinge-area (beak) of the lower valve. When the type of *C. madrasensis* was compared with the type of *C. gryphoides* var. *cuttackensis*, the recess in the former was found to be less developed than in the latter. In the present investigation, this recess in *C. madrasensis* was noticed to be better developed when compared with its counterpart in *C. virginica*. However, such a thing could be expected in a comparative study and does not alter the systematic position of the oysters.

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Flora of Mothronwala Swamp Forest (District: Dehra Dun, U.P., India)

BY

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[*Continued from Vol.* **67** (2) : 186]

SCROPHULARIACEAE

Mimulus strictus Benth. (3911)
Flowers—Throughout the year.

Limnophila rugosa (Rotht Merrill (5558)
Flowers—July/August.

Bacopa monnieri (Linn.) Pennell (7259)
Flowers—Almost throughout the year.

Torenia cordifolia Roxb. (6247)
Flowers—August/September.

Lindernia crustacea (Linn.) F. Muell. (5591; 7258)
Flowers—August/September.

L. hookeri (Clarke) Wettst. subsp. **kumaunensis** Pennell (6247 A)
Flowers—October.
Note: A very rare plant.

L. cordifolia (Colsmann) Merrill (5552 ; 5557)
Flowers—July/August.

L. ciliata (Colsmann) Pennell (7257)
Flowers—July/August.

L. anagallis (N. L. Burm.) Pennell *var.* **grandiflora** (Retz.) Mukerjee (5565)
Flowers—August/September.

Veronica anagallis-aquatica Linn. (3931 ; 6282)
Flowers—Throughout the cold season.

Centranthera nepalensis D. Don (5553)
Flowers—September/October.

PEDALIACEAE

Sesamum indicum Linn. (5583)
Flowers—July/August.

ACANTHACEAE

Nelsonia canescens (Lamk.) Spreng. (3935 ; 5520 ; 8016)
Flowers—February to June.

Hygrophila polysperma (Roxb.) T. Anders. (5519 ; 8043)
Flowers—May/June.

H. salicifolia (Vahl) Nees (3930, 5527, 7276)
Flowers—March/April and July to September.

Eranthemum nervosum (Vahl) R. Br. (3915 ; 8031)
Flowers—March/April.

Hemigraphis latebrosa Nees *var.* **heyneana** Bran. (8010)
Flowers—January/February.

Barleria cristata Linn. (6261)
Flowers—September/October.

Lepidagathis incurva D. Don (3927 ; 5499 ; 8018)
Flowers—December to March.

Justicia quinqueangularis Koen. ex Roxb. (5478 ; 5525 ; 6242)
Flowers—June to September.

J. procumbens Linn. *var.* **simplex** (D. Don) Yamazaki (6225, 7242)
Flowers—August/September.

Adhatoda vasica Nees (3928)
Flowers—March/April.

Rungia repens (Linn.) Nees (3925 ; 6288)
Flowers—Cold season.

R. pectinata (Linn.) Nees (6251)
Flowers—September/October.

Dicliptera roxburghiana Nees (3997)
Flowers—March to May.

VERBENACEAE

Lantana camara Linn. *var.* **aculeata** (Linn.) Moldenke (3983)
Flowers—Most part of the year.

L. crenulata Otto & Dietr. (6295)
Flowers—Most part of the year.

Phyla nodiflora (Linn.) Greene (5508)
Flowers—May/June.

Callicarpa macrophylla Vahl (3955)
Flowers—March/April.

Premna latifolia Roxb. *var.* **mucronata** (Roxb.) Clarke (8048)
Flowers—April/May.

Clerodendrum indicum (Linn.) O. Ktze. (7233)
Flowers—August/September.

C. viscosum Vent. (3921)
Flowers—February to May.

C. serratum (Linn.) Moon (5590)
Flowers—August/September.

Caryopteris wallichiana Schauer (3954)
Flowers—February to April.

LABIATAE

Acrocephalus indicus (Burm.) O. Ktze. (6217 ; 8068 ; 8069)
Flowers—September/October.

Orthosiphon rubicundus Benth. (5539)
Flowers—June/July.

Plectranthus japonicus (Burm. f.) Koidz. (8799)
Flowers—October to December.

Colebrookea oppositifolia Smith (8005)
Flowers—January/February.

Mosla dianthera (Buch.-Ham. ex Roxb.) Maxim. (5526, 7269)
Flowers—June to September.

Nepeta hindostana (Roth) Haines (6219)
Flowers—August/September.

Anisomeles indica (Linn.) O. Ktze. (8084)
Flowers—December.

Leucas lanata Benth. (3994)
Flowers—April to June.

L. mollissima Wall. (7282)
Flowers—August/September.

L. nutans Spreng. (5584)
Flowers—August.

Teucrium stoloniferum Roxb. (5517)
Flowers—May/June.

Ajuga bracteosa Wall. ex Benth. (7238)
Flowers—July to September.

NYCTAGINACEAE

Boerhaavia diffusa Linn. (7240)
Flowers—August to November.

AMARANTHACEAE

Celosia argentea Linn. (6257; 8012)
Flowers—October to January.

Amaranthus spinosus Linn. (5568)
Flowers—July/August.

Aerva sanguinolenta (Linn.) Blume (3981)
Flowers—March/May.

Achyranthes aspera Linn. (8086)
Flowers—September to November.

A. bidentata Blume (7275)
Flowers—August/September.

Alternanthera sessilis (Linn.) DC. (5566)
Flowers—July/September.

POLYGONACEAE

Polygonum plebejum R. Br. (3916)
Flowers—Cold season.

P. stagninum Buch.-Ham. ex Meissn. (5513; 8075; 8078; 12484; 5528)
Flowers—August to November.

P. barbatum Linn. subsp. **gracile** Danser (5504)
Flowers—April to June.

P. hydropiper Linn. (8074; 5547)
Flowers—August to November.

LAURACEAE

Persea odoratissima (Nees) Kosterm. (3958)
Flowers—March/April.

P. gamblei (King ex Hook. f.) Kosterm. (8026)
Flowers—March.

Phoebe lanceolata Nees (8039)
Flowers—Late March/Late April.

ELAEAGNACEAE

Elaeagnus conferta Roxb. (3910)
Flowers—November to January,

EUPHORBIACEAE

Euphorbia hypericifolia Linn. (5587)
Flowers—July to September.

E. hirta Linn. (5569)
Flowers—Throughout the year.

E. dracunculoides Lamk. (5536)
Flowers—June/July.

Phyllanthus urinaria Linn. (7234)
Flowers—Cold season.

P. virgatus J. G. Forst. (6267)
Flowers—September/October.

Bischofia javanica Blume (3901 ; 3902)
Flowers—March. Fruits—Ripen in June.

Antidesma diandrum Roth (5521)
Flowers—May/June.
Note: Leaves have an acid taste.

Mallotus philippensis (Lamk.) Muell.-Arg. (3945)
Flowers—November to January ; Fruits—April/May.

Baliospermum montanum (Willd.) Muell.-Arg. (8046)
Flowers—April to June.

Sapium sebiferum (Linn.) Roxb. (3995)
Flowers—May/June.

URTICACEAE
(Incl. MORACEAE)

Broussonetia papyrifera Vent. (1799)
Flowers—June/July.

Morus alba Linn. (8024)
Flowers—March/April.

Ficus gibbosa Blume *var.* **cuspidifera** Miq. (8092)
Receptacles ripen during January to March.

F. rumphii Blume (8096 A)
Receptacles ripen during May/June.

F. religiosa Linn. (3999)
Receptacles ripen during March to May.

F. arnottiana Miq. (8096 B)
Receptacles ripen during July.

F. hispida Linn. f. (3968, 8033)
Receptacles ripen April onwards.

F. semicordata Buch.-Ham. (8096 C)
Receptacles ripen during August/September.

F. hederacea Roxb. (5492)
Receptacles ripen during rainy season.

F. palmata Forsk. (8096)
Receptacles ripen during July and October.

F. auriculata Lour. (8096 D)
Receptacles ripen during rainy season.

F. racemosa Linn. (8096 E)
Receptacles ripen during April to July.

Maclura cochinchinensis (Lour.) Corner (3944)
Flowers—March to May; Fruits—September to November.

Elatostema cuneatum Wight (7283)
Flowers—August/September.

Boehmeria platyphylla D. Don (7293)
Flowers—September/October.

Pouzolzia pentandra Benn. (5524)
Flowers—May to July.

SALICACEAE

Salix tetrasperma Roxb. (6245 ; 6278 ; 8072)
Flowers—September/October.

ORCHIDACEAE

Eulophia flava (Lindl. ex Royle) Hook. f. (553 ; 8050)
Flowers—June.

Zeuxine strateumatica (Linn.) Schlechter (8014)
Flowers—February.

Habenaria commelinifolia Wall. ex Lindl. (7249)
Flowers—August/September.

H. diphylla Dalz. (5579)
Flowers—August.

Peristylus lawii Wight (5580)
Flowers—August.

ZINGIBERACEAE

Globba orixensis Roxb. (5582)
Flowers—August.

Curcuma angustifolia Roxb. (5518)
Flowers—June.

C. longa Linn. (7262)
Flowers—August.

Hedychium coronarium Koen. ex Retz. (5570)
Flowers—May/June.

Zingiber roseum Rosc. (5477)
Flowers—November.

Costus speciosus Smith (5563)
Flowers—July/August.

Alpinia bracteata Roxb. (7261)
Flowers—August.

HYPOXIDACEAE

Curculigo orchioides Gaertn. (5542)
Flowers—July.

DIOSCOREACEAE

Dioscorea belophylla Voigt (6271, 8065)
Flowers—October.

D. bulbifera Linn. (5562 ; 8057)
Flowers—August to October.

D. pentaphylla Linn. (7272)
Flowers—August/September.

LILIACEAE

Smilax glaucophylla Klotzsch (5489 ; 6226)
Fruits—November/December.

Asparagus adscendens Roxb. (5544 ; 6294)
Flowers—October to December.

Gagea reticulata Schultes f. (8091)
Flowers—February.

Gloriosa superba Linn. (12486)
Flowers—January/February.

COMMELINACEAE

Commelina benghalensis Linn. (7243)
Flowers—July to September.

C. paludosa Blume (5570 ; 8056)
Flowers—July/August.

Murdannia scapiflorum (Roxb.) Royle (5545)
Flowers—July.

M. nudiflorum (Linn.) Brenan (5581)
Flowers—August.

Floscopa scandens Lour. (3971 ; 6260)
Flowers — September/October and also March/April.

JUNCACEAE

Juncus bufonius Linn. (8020)
Flowers—February.

PALMAE

Calamus tenuis Roxb. (7292)
Flowers—September.

ARACEAE

Arisaema tortuosum (Wall.) Schott (5555)
Flowers—July/August.

Remusatia vivipara Schott (7232)
Flowers—August/September.

Acorus calamus Linn. (3904)
Flowers—March to August.

CYPERACEAE

Cyperus kyllingia Endl. (3972)
Flowers—April.

C. globosus Allioni (5532, 5511)
Flowers—May/June.

C. iria Linn. (8100)
Flowers—August/September.

C. distans Linn. f. (5596)
Flowers—July/August.

C. nutans Vahl (3985 ; 5561 ; 6286)
Flowers—May to October.

C. pilosus Vahl (5529)
Flowers—July to September.

C. rotundus Linn. [5600 (2)]
Flowers—August to October.

C. cyperoides (Linn.) O. Ktze. (5557)
Flowers—July/August.

Fimbristylis dichotoma (Linn). Vahl (5531)
Flowers—June to October.

Scirpus erectus Poir. (6230)
Flowers—August/September.

Scleria tessellata Willd. (7263)
Flowers—August/September.

S. levis Retz. (7264 ; 5599)
Flowers—August/September.

Carex fedia Nees (3907 ; 8032 ; 8036)
Flowers—Throughout cold season.

GRAMINEAE

Paspalum scrobiculatum Linn. (5550, 5560, 5575, 6296)

Flowers—July to October.

Digitaria adscendens (H.B.K.) Henr. (8052, 8778)

Flowers—July to September.

Cyrtococcum patens (Linn.) A. Camus (6229, 6266)

Flowers—September.

Echinochloa colonum (Linn.) Link (5797 ; 5533)

Flowers—June to August.

E. crusgalli (Linn.) P. Beauv. (5576 ; 5598 ; 6231)

Flowers—August/September.

Oplismenus compositus (Linn.) P. Beauv. (6281)

Flowers—September to November.

Arundinella nepalensis Trin. (6298, 8002, 8795)

Flowers—October/November.

Setaria plicata (Lamk.) T. Cooke (6300)

Flowers—October/November.

S. glauca (Linn.) P. Beauv. (5546 ; 5556)

Flowers—June to November.

Pennisetum orientale L. C. Rich. (5597)

Flowers—July to September.

Coix lacryma-jobi Linn. (6232)

Flowers—August/September.

Chionachne koenigii (Spreng.) Thw. (8003)

Flowers—Late December/January.

Hemarthria compressa (Linn. f.) R.Br. [5600 (1)]

Flowers—July/August.

Imperata cylindrica (Linn.) P. Beauv. (3984, 5559)

Flowers—May to August.

I. cylindrica (Linn.) Beauv. *var.* **latifolia** (Hook. f.) C. E. Hubbard (6276 ; 8796)

Flowers—October.

Saccharum spontaneum Linn. (6233 ; 5498)

Flowers—September/October.

Narenga porphyrocoma (Hance) Bor (8019)

Flowers—February.

Arthraxon prionodes (Steud.) Dandy (8793)

Flowers—Late November/December.

A. lancifolius (Trin.) Hochst. (8070)

Flowers—October.

Apluda mutica Linn. (6252 ; 6269 ; 6287)

Flowers—August to November.

Rottboellia exaltata Linn. f. (6280)

Flowers—September/October.

Capillipedium assimile (Steud.) A. Camus (6285 ; 8004, 8087)

Flowers—September/October.

Sorghum halepense (Linn.) Pers. (6237)

Flowers—September.

Pseudosorghum fasciculare (Roxb.) A. Camus (6283 ; 6299)

Flowers—October.

Vetiveria zizanioides (Linn.) Nash (7265 ; 9794)

Flowers—August/September.

Dichanthium annulatum (Forsk.) Stapf (8099)

Flowers—March/April.

Themeda arundinacea (Roxb.) Ridley (8001)

Flowers—January.

Polypogon monspeliensis (Linn.) Desf. (3979 ; 3979A)

Flowers—April to June.

Chrysopogon fulvus (Spreng.) Chiov.

Flowers—August/September.

Eleusine indica (Linn.) Gaertn. (8040)

Flowers—March/April.

E. coracana (Linn.) Gaertn. (6268)

Flowers—September/October.

Arundo donax Linn. (6277A)

Flowers—September/October.

Phragmites communis Trin. *var.* **communis** Bor (6277 ; 8076)

Flowers—October.

Eragrostis tenella (Linn.) P. Beauv. ex Roem. et Schult. (5530)

Flowers—June.

E. unioloides (Retz.) Nees ex Steud. (5600 ; 8081)

Flowers—July to November.

E. gangetica (Roxb.) Steud. (8009)

Flowers—Late January to February.

Desmostachya bipinnata (Linn.) Stapf (5549 ; 5574)

Flowers—July/August.

POLYPODIACEAE

Cheilanthes farinosa (Forsk.) Kaulf. (7287)

Sori—August/September.

Adiantum caudatum Linn. (8041)

Sori—March/April.

A. philippense Linn. (7288)

Sori—August/September.

Diplazium esculentum (Retz.)Sw. (5481 ; 8789; 6289)

Sori—October to December.

D. polypodioides Blume (7289)

Sori—August/September.

Dryopteris extensa (Blume) O. Ktze. (5480)

Sori—November/December.

D. moulminensis (Bedd.) C. Chr. (8792)

Sori—November.

D. prolifera (Retz.) C. Chr. (5485, 7290, 8782)

Sori—October to Dceember.

D. arida (Don) O. Ktze. (7284, 8008, 8781)

Sori—September to January.

D. papyracea (Bedd.) C. Chr. (8059)

Sori—June/July.

SCHIZEACEAE

Lygodium flexuosum (Linn.) Sw.

Sori—September.

In conclusion it may be indicated that in this swamp forest flora, Malayan species dominate (120) and Leguminosae has the maximum representation (51 species). Interestingly, the following species which generally occur at higher altitudes (1500-2000 m) are also represented in this flora :

1. *Acer oblongum* Wall. ex DC.
2. *Acronychia pedunculata* Miq.
3. *Elaeagnus conferta* Roxb.
4. *Gagea reticulata* Schultes f.
5. *Lindernia hookeri* (Clarke) Wettst. subsp. *kumaunensis* Pennell.
6. *Persea gamblei* (King ex Hook. f.) Kosterm.
7. *P. odoratissima* (Nees) Kosterm.
8. *Phoebe lanceolata* Nees.
9. *Sabia paniculata* Edgew.
10. *Viola canescens* Wall. ex Roxb.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—16

Capitonidae, Indicatoridae and Picidae (part)

BY

HUMAYUN ABDULALI

[*Continued from Vol.* 70 (2) : 345]

(*With a sketch*)

This part deals with 537 specimens of 48 species and subspecies. Mr. S. A. Hussain, Research Assistant, helped with the measurements and prepared the accompanying sketch.

777 **Megalaima virens marshallorum** Swinhoe (Himalayas) Himalayan Great Barbet 4 : 106

16 : 7 ♂♂ (3 juv.) 7 ♀♀ 2 o?
1 Kowar, Kistwar, Kashmir; 1 Kangra Dist., Punjab; 1 Mashobra, Koti State, 7 Simla Hills; 1 Rampur, Guptakashi, Garhwal, 2 Almora; 3 no data.

Six specimens from Central and Eastern Bhutan, not yet registered, have been examined and are referred to under the next subspecies, No. 778.

3 juveniles all males obtained in July can be separated from the adults by their smaller bills, and the yellowish green of the collar appearing more scattered and lacking the streaked effect. The heads also show a tinge of green.

	Wing	Bill	Tarsus	Tail
♂♂	143(2), 146, —	40, 41, 42	32, 33, 34	97, 98, 100
♀♀	141-150 av. 145·8	40-41	29-33 av. 32	94-103 av. 100
	(♂♀ 146-152	*c.* 46	23	100-109)

778 **Megalaima virens magnifica** Baker (Machi, Manipur) Assam Great Barbet 4 : 107 (part)

8 : 6 ♂♂ 2 ♀♀
1 Chalna Khel, Nepal; 1 Kurseong; 2 Temi, West Sikkim, 1 Sikkim 1 Humgrum, N. Cachar, 1 Naga Hills, 1 Margherita, Lakhimpur, Assam.

As indicated under 777, six unregistered specimens from Bhutan have also been examined. All of them, as well as those listed above, differ from *marshallorum* in showing more yellow on the underparts. Those from Nepal, Kurseong, Sikkim, and Central Bhutan (1) differ from those from Eastern Bhutan and Assam in having the brown of the back and breast duller than in *magnifica*, forming an intermediate population which is included here in accordance with the distribution in IND. HANDBOOK.

	Wing	Bill	Tarsus	Tail
♂♂	140-148 av. 143	one 35, 40-45	29-33 av. 31	86-100
♀♀	138, 140, 141, 148	41, 43, 44(2)	31, 32, 33(2)	90, 91, 97, 99

The measurements include those of the unregistered specimens from Bhutan.

The amount of black on the bill increases eastwards into Bhutan, but those from Margherita and Humgrum have only the tips black.

779 **Megalaima virens mayri** Ripley (Dreyi, Mishmi Hills, N.E. Assam) Mishmi Great Barbet 4 : 107 (part)

nil.

EL **Megalaima virens clamator** Mayr (Shweli-Salween Divide, 8000′, Burma)

2 ♂♂ *Mt. Victoria, Pakokku Hill Tracts, Burma.*

Wing 148 ; bill 43, 44 ; tarsus 29, 32 ; tail 89, 95.

The bills are much heavier than indicated by the measurements.

The tertials do not appear to differ from those in *magnifica* nor do the bills show a greater amount of black ; but the almost complete absence of the yellow streaks on the nape and the generally duller plumage show a closer affinity to the description of *clamator* than to *magnifica*.

780 **Megalaima zeylanica caniceps** (Franklin) (On the Ganges between Calcutta and Benares, and the Vindhiyan Hills between the latter place and Gurrah Mundela on the Nerbudda) Northern Green Barbet 4 : 110

17 : 9 ♂♂ 5 ♀♀ 3 o ?

1 Madhopur, 1 Dharmasala, Punjab ; 1 Delhi ; 1 Chikalda, Berar ; 1 Anantagiri, Vizagapatam ; 1 Kameli, Bailadila, 1 Basrur, 1 Amraoti, Bastar, M.P. ; 1 Chamundia, Daspalla, 1 Badrama, Bamra, 1 Koira, Bonai ; 1 Harbhanga Bund, Orissa ; 1 Dehra Dun, 2 Pilibit Terai, U.P. ; 2 no data.

	Wing	Bill	Tarsus	Tail
5 northern ♂♀	117-128 av. 124·6	31-35 av. 33	27-31 av. 29	78-84
10 southern ♂♀	113-123 av. 118	30-36 av. 32	26-32 av. 29	70-79 av. 74·5

Whistler's *kangrae* described for its larger size is not now accepted, but the usual north-south cline is evidenced by the above measurements. There are variations in the intensity of the brown of the head and four (2 Punjab, 2 Pilibhit Terai) have their heads paler and the streaks broader than in the others.

781 **Megalaima zeylanica inornata** Walden (Malabar) Western Green Barbet **4** : 110

13 : 6 ♂♂ (1 juv.) 3 ♀♀ 4 o ? (2 juv.)
1 Andheri, 1 Bhandup, Bombay ; 1 Karnala, Kolaba ; 3 Khandala ; 4 Ratnagiri; 1 Kadra, 1 Karwar, N. Kanara ; 1 Kuravenuth, Travancore.

All of them have the upperparts washed with brown, and very few signs of streaking particularly on the head and nape. Specimens from Ratnagiri show more brown and very little green on the underparts. No. 21284, collected at Karnala on 15th March while being fed by another, has a short bill and pale head, and is no doubt a juvenile.

781a **Megalaima zeylanica** subsp.

3 : 2 ♂♂ 1 ♀
1 Hathidari, Palanpur, N. Gujarat ; 1 Malegaon, 1 Laochali, Surat Dangs.

Sálim Ali in 'Birds of Gujarat' (*JBNHS* **52**: 448) recorded 11 specimens from Gujarat as *inornata*, but in IND. HANDBOOK (**4** : 150) Gujarat is said to be within the range of *caniceps*. The only three from Surat Dangs (2) and Hathidari, Palanpur, N. Gujarat, available here have pale unstreaked heads and resemble the juvenile of *inornata*. One obtained on 10th March 1948 is marked as having enlarged gonads and there is no evidence of any of them not being adult. If this is supported by additional material, there is no doubt that they are sufficiently distinct to be trinomially separated.

782 **Megalaima zeylanica zeylanica** (Gmelin) (Ceylon) Ceylon Green Barbet **4** : 108

1 Ceylon ♀ ? No. 10435
Wing 113 ; bill 32 ; tarsus 27 ; tail 70.

The head and breast are darker than in *inornata*, and both head and breast are streaked with pale shaft-streaks. The wings also carry tiny white spots which are absent in most *inornata*. One ♀ No. 10443 from Kuravenuth, Travancore, approaches it in darkness of colour and streaking and was one of the two specimens available to Whistler (*JBNHS* **38** : 187) when he decided that birds from South Travancore were nominate *zeylanica*. It lacks the prominent shaft-streaks on the head and breast, and can be well matched with *inornata* from further north. With the material available, I would not admit *zeylanica* to the Indian mainland.

783 **Megalaima lineata rana** Ripley (Bajora, Dailekh District, West Nepal) Western Lineated Barbet

784 **Megalaima lineata hodgsoni** Bonaparte (Nepal, restricted to Simra, Central Nepal) Eastern Lineated Barbet **4**: 111

23 : 7 ♂♂ 13 ♀♀ 3 o?

The material available does not permit the separation of any bird as *rana*, nor is it possible to geographically isolate those with the brighter green lower underparts (*kutru* Mukherjee). Eastern and Burmese birds, however, have heavier and more conical beaks than those from the west, but three specimens from Burma, under (c), are confusing, and I am for the moment only drawing attention to the differences.

(*a*) *hodgsoni* 8 : 4 ♂♂ 4♀♀

2 Partapur, 1 Bankulwa Morang, Nepal; 1 Ranibag, U.P.; 1 Baghowni, Bihar; 1 Gurguria, Simlipal District, Orissa; 1 Kurseong, 1 Sevoke, Darjeeling, Bengal.

	Wing	Bill	Depth at base	Tail
♂♂	123, 123, 135	32, 32·5, 34·3, 35	13·6, 14·2, 14·3, 14·6	76, 77, 84, 87
♀♀	133(3), 136	32, 36, 36·4, 36·5	14, 14·6, 14·7, 15·3	73, 77, 80, 82
(♂♀	123-137	30-33	—	82-86)

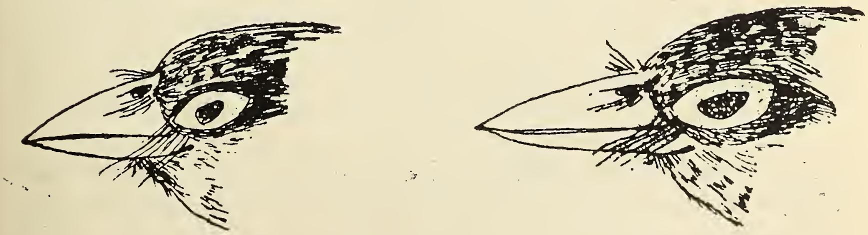
(*b*) Assam and Burma, with conical bills 12 : 3 ♂♂ 8 ♀♀ 1 o?

1 Sadiya, 1 Goalpara, 1 South Sylhet, 1 North Cachar, 1 Roopchena, 1 Laisingh, Cachar, Assam; 1 *Laindon, Thayetmyo*, 1 *Theme, Prome*, 1 *Legongyi, Henzada*, 2 *Maymyo*, 1 *Sabagyi Village, west of Yomas, Bassein, Burma.*

	Wing	Bill	Depth at base	Tail
♂♂	123, 125, 135	32·5, 34, 34·5	15·1, 15·4, 16·1	78(2), 85
♀♀	123-138 av. 130·4	31·9-37 av. 34·2	14-16·3 av. 15·2	75-82 av. 79

The depth of the bill at base and the conical shape is better shown in the accompanying sketch than by the measurements.

MEGALAIMA LINEATA



EASTERN

Bill of 10472 ♀

WESTERN

Bill of 10464 ♀

Sp. No. 19467 from west of Yomas, Bassein, Burma (wing 123 ; bill 32 ; depth 16 ; tail 78) is distinguishable from all the other specimens by the uniformly blackish brown chin and upper breast, with no streaks, and the head broadly streaked with buff as in the three referred to as juveniles under (c) below.

♀ No. 10465 from Bankulwa Morang, Eastern Nepal, has a similar trend to darkness of the throat and upper breast, but not so pronounced. This is presumably a juvenile character also exhibited in *Megalaima viridis* No. 785 (q.v.).

(*c*) 3 : 1 ♀ 2 o?

1 *Lower Chindwin* ; 2 *Southern Shan States, Burma.*

Nos. 10461, 10462 and 10468 (wing 130, 131, 134 ; bill 34·3, 34·5, 34·7 × 14·4, 15·5, 15·6 ; tail 79, 80, 80).

These have prominent wide pale streaks at the centre of the feathers of the head, giving the whole area a whitish rather than brown effect as in the other specimens. Mr. Bond, to whom a specimen was sent, thinks that this represents a juvenile plumage. The three however lack the thick bills of the others from Burma.

785 **Megalaima viridis** (Boddaert) (Mahe, India) Small Green Barbet **4**: 113

21 : 11 ♂♂ 9 ♀♀ 1 o?

1 Malegaon, Surat Dangs, Gujerat ; 2 Khandala, 1700′, 1 Lohgad, Malavi, Poona ; 1 Ratnagiri, 1 Gowadsagar, Goa Frontier ; 4 Karwar, 2 Santgal ; 1 Katgal, 1 Sirsi, N. Kanara ; 2 Shembaganur, 2 Palni Ghats, 1 Kodaikanal ; 1 Karupadana, Cochin State ; 1 Shevaroy Hills, Salem District.

J. Hayes-Lloyd (*Ibis* 1873, p. 125, reproduced in *Stray Feathers* 1 : 419) had separated northern birds as *M. sykesi* as ' distinguished by their larger size and pronounced markings.' There is some variation in the colour of the head and also the markings on the breast, but they do not appear to represent any distinct populations.

	Wing	Bill	Tarsus	Tail
Northern 1♂* 3♀♀	103, 106*(2), 107	24*, 25(2), 27	24, 25, 26*(2)	60*(2), 65(2)
Ratnagiri southwards 10 ♂♂ 6♀♀	96-102, av. 100·5	22-26, av. 24	24-25, av. 24·5	53-64, av. 58·3
(IH	97-113	from skull 24-29 *c*. 27		65-70)

Four southern birds [Ratnagiri, N. Kanara (2) and Palnis] obtained in May and June have brown heads, in which the absence of pale edges to the feathers shows a sleekness absent in the others. In Sp. No. 20709 from Shembaganur, obtained on 18 February 1958, the edges of the feathers of the head are tinged with pale green. Sp. No. 10482 a ♂ from Karwar, has a dark chin and breast similar to that in the larger barbet *lineata* from Sabagyi Village, west of Yomas, Bassein, Burma, and this is presumably a juvenile character.

786 **Megalaima flavifrons** (Cuvier) (Ceylon) Yellowfronted Barbet
4 : 120

4 : 2 ♂♂ 1 ♀ 1 o?

1 Rygam Korale, 1 Walgama, 1 Rasagalli-Balangordi (?), 1 Pundulaya, Ceylon.

	Wing	Bill	Tarsus	Tail
♂♀	90(2), 91, 92	20, 21, 22(2)	20(2), 23, 24	53, 54(3)
	(IH 87-93	from skull 21-25	22-25	52-58)

787 **Megalaima franklinii franklinii** (Blyth) (Darjeeling) Goldenthroated Barbet
4 : 124

15 : 4 ♂♂ 2 ♀♀ 9 o?

1 Dharamsala, Punjab (?); 1 Bans Bahari, Nepal; 1 Singhik, N. Sikkim, 1 Sikkim; 1* Mishmi (Abor Expedition), 2 * Rotung, Abor Country; 2 Humgrum, N. Cachar; 1 *Loi Song*, 1 *Loi Pengye*, 2 *North Shan States*; 1 *Bamboo Camp*, 1 *Mt. Victoria, Burma.*

All have a black stripe over the eye and there is nothing to suggest *ramsayi*. There is considerable variation in the shades of green on the upper and lower parts, which cannot be localised except for 3 from Mishmi and Abor Country and another from N. Shan States which are deeper green above and have a curious olive wash below (marked with asterisk above). Three others from the N. Shan States have their upperparts equally dark, but the underparts distinctly paler than in all the others. The material available does not permit any conclusions.

A series of eight from eastern and central Bhutan, not yet registered, has been examined and is included in the measurements. Those from central Bhutan show more green than the eastern specimens, but the differences may be included in the range of variation over the whole series.

Specimen No. 10534 is marked 'Dharamsala, Punjab, Col: H. W. Wells' and the label bears the printed words 'Bombay Natural History Society—Mammal Survey'. The serial number however does not appear on this label. Wells collected some birds in Assam while directing the Mammal Survey in Assam in 1919-1920, and later also in the Punjab. It would appear that there has been mix-up in the labels and I do not accept this as extending the accepted range of this species west of Central Nepal.

788 **Megalaima asiatica asiatica** (Latham) (Calcutta) Bluethroated Barbet
4 : 116

32 : 18 ♂♂ 8 ♀♀ 6 o?

Though no races have yet been named from this area, the 31 specimens (1 missing) available can be separated into 2 groups.

24 : 15 ♂♂ (1 juv.) 5 ♀♀ 4 o ? (1* missing).

(*a*) 1 Dharamsala, Kangra ; 3* Bhagat State, 1 Bhajji State, Simla ; 1 Dehra Dun, 1 Almora, U.P. ; 1 Tribeni, Nepal ; 1 Rangpo, 1 Martam, Rogni Valley, Sikkim, 1 Darjeeling, 1 Calcutta ; 1 Tenai T.E., Goalpara, 3 Dibrugarh, 1 Sadiya, 1 Bagho Bahar, Cachar, Assam ; 2 Dinapur Road, 1 Imphal area, Manipur ; 1 *Pumsin*, 1 *Gora*, 1 *Tawmaw*, *Chindwin Expedition.*

One ♂ No. 10501 from Bagho Bahar, Cachar, has an olive-green wash on the underparts, similar to that shown by *M. franklinii* from the Mishmi and Abor Country (q.v.).

Four unregistered specimens from Bhutan agree with this group and include one with the upper and underparts splashed with red. A red form *rubescens* described by Baker from ' the highest ranges in the east of the Cachar Hills ' is said to be an erythristic form of the nominate race.

(*b*) Similar to (*a*) but with thicker and more conical bills.

8: 3 ♂♂ 3 ♀♀ 2 o ?

1 Gusyang, N. Cachar, 1 *N' Krang, Upper Burma* ; 1 *Ft. Stedman*, 1 *Chin Hills* ; 1 *Thayetmyo*, 2 *Nyaunggyo*, *Prome Dist.*, 1 *Chandaung*, *Henzada Dist.*

There is not much difference in size between the two groups :

		Wing	Bill	Tarsus	Tail
(a)	12 ♂♂	101-112 av. 104·3	25-27 av. 25·8	26-28	62-70 av. 65
	8 ♀♀	98-105 av. 100·2	25-27 av. 26	25-27	60-67 av. 63·8
(*b*)	8 ♂♀	98-108 av. 103	25-27 av. 26	25-27	60-67 av. 62
	(IH ♂♀	97-109	from skull 23-28	24-28	59-68)

Some birds show shiny yellowish green on the upperparts and I accept Mr. Bond's suggestion that this is seasonal and due to wear. Mr. Bond writes : ' The colour is only on the top of the feather, the underside is dark grey. Unlike the barbs of most bird feathers which disappear with wear, the yellow barbs of these feathers appear to be very tough and remain on the rachis after the barbules have worn away. The tips of these remaining barbs then produce a yellowish cast to the upperparts, so the yellowish appearance is produced by wear.'

789 **Megalaima australis cyanotis** (Blyth) (Arakan) Indian Blue-eared Barbet 4 : 121

4 : 3 ♂♂ 1 o ?

1 Roopchena, 2 Bagho Bahar, Cachar ; 1 *Konka, N. Shan States.*

Wing	Bill	Tarsus	Tail
83, 83, 86	20(3)	20(3)	47, 48, 50
(♂♀ 77-85	18-21	*c.* 21	45-50)

In IND. HANDBOOK (**4** : 160) the reference to Stuart Baker's FAUNA is inadvertently omitted.

790 **Megalaima rubricapilla malabarica** (Blyth) (Malabar) Malabar Crimsonthroated Barbet **4** : 129

15 : 8 ♂♂ (1 juv.) 5 ♀♀ 2 o?

1 Kadra, 1 Ramankoli, 2 Hattikeri, 1 Maigui, 1 Akkgodda, 1 Kumta Div., 1 North Kanara; 1 Mercara, Coorg; 2 Gudalur, Nilgiris; 2 Wynaad; 1 Murchiston, Ponmudi, 1 Santhanpara, Cardamom Hills, Kerala.

	Wing	Bill	Tarsus	Tail
♂♂	79-83 av. 80·5	15-16	18-20	35-39 av. 36
♀♀	79-82 av. 80	16-17	18-20	33-38 av. 34
	(IH ♂♀ 78-88	from skull 15-18	17-20	35-39)

There is some variation in the green both on the upper and lower parts which cannot be associated with any place or season. ♂ No. 10589 collected on 31 March 1900 in N. Kanara is presumably juvenile and lacks the red round the eye, on the head, chin, and breast. The area round the eye and the chin are yellowish, and though paler and less distinct are very suggestive of the nominate race from Ceylon.

791 **Megalaima rubricapilla rubricapilla** (Gmelin) (Ceylon) Ceylon Small Barbet **4** : 130

1 ♀ Colombo, Ceylon.

Wing 78 ; bill 17 ; tarsus 19 ; tail 33.

792 **Megalaima haemacephala indica** (Latham) (Calcutta) Crimson-breasted Barbet **4** : 127

56 : 27 ♂♂ 20 ♀♀ 9 o?

In IND. HANDBOOK (**4** : 163) the type locality is said to be 'India' and *luteus* Lesson (Pondicherry) is synonymised with this race. Stuart Baker indicated the type locality of *indica* as Calcutta and called it the 'Burmese Crimsonbreasted Barbet'.

Six specimens from Burma could be separated from the others by the heavier greenish streaking on the underparts, in which the paler interspaces in four (Sandoway, Henzada) are well washed with yellow. Of three specimens, 1 Calcutta, 1 Salt Lake, 24-Parganas, Bengal, and 1 Kamrup, Assam, borrowed from the Zoological Survey, the single bird from Calcutta shows a tendency towards the brightness of those from Burma but this is not evident in specimens from Assam. Larger series from different areas are necessary to determine the separability of *luteus* from Pondicherry (and peninsular India).

In some specimens, including one from Taungyi, and others from

Assam and India, the streaks on the underparts are so dark as to appear grey rather than green.

(*a*) 50 : 25 ♂♂ (1* juv.) 19 ♀♀ 6 o?

2 Rawalpindi, 2 Ambala, Punjab ; 1 Delhi ; 1 Bharatpur, Rajasthan ; 1 Deesa, Palanpur, 1 Amreli, Kathiawar, 1 Gir Forest, 1 Dabka, Baroda, 1 Dediapada, Rajpipla, 1 Sarwar, 1 Malegaon, Surat Dangs ; 3 Bombay, 3 Hhandala, 1 Poona, 2 Satara, 1 Rajapur, Ratnagiri; 1 Andle, 1 Silloor, 2 Karwar, 1 Kattikeri, N. Kanara ; 1 Mysore ; 1 Tope, Palnis ; 1 St. Thomas's Mount, Madras, 1 Palkonda Hills, 1 Koduru, 1 Cumbum Valley; 1 Anantagiri, 1 Jeypore Agency, Vizagapatam; 1 Konta; 1 Amraoti, Bastar Dt., 1 Saugor, C.P. ; 2 Barkul, 1 Mayurbhanj, Orissa ; 1 Meerut; 1 Pilibhit, 1 Cawnpur ; 2 Baghownie, Tirhut, Bihar, 1* Dibrugarh, Assam; 2 no data.

(*b*) 6 : 2 ♀♀ 1 ♂ 3 o?

1 *North Shan States,* 2 *Taungyi, S. Shan States,* 1 *Prome Dt.,* 1 *Sandoway,* 1 *Myogwin, Henzada Dt.*

	Wing	Bill	Tarsus	Tail
(*a*) Indian	♂♂ 78-85 av. 81	17-19	19-21	32-36 av. 34
	(IH 78-84	from skull 16-20	17-21	33-38)
	♀♀ 75-83 av. 80	17-19	19-21	30-34 av. 33·8
	(IH 75-83	17-20	18-21	30-37)
(*b*) 6 Burmese	♂♀ 83-86 av. 84	17-19	18-20	33-36 av. 34·5
	(♂♀ 77-89	17-18	*c.* 20	34-36)

12 specimens from the north (Punjab, Delhi, Cawnpore, Meerut, Baghowni, Tirhut, and Pilibhit) have their upperparts a paler uniform green with a tinge of yellow. Except for similar tendency in five from Palkonda Hills and Kodur in S. Cuddappah, Cumbum Valley, Kurnool Dist., and two from Orissa, this colour does not appear uniformly in any of the others.

Sp. No. 10553 from Mysore (February 1915) shows no green on the head and body and, except for the red on the forehead and upper breast, is largely white or yellowish. In the wing except for 2 primaries (6th & 7th) on one side and 3 (4th, 5th, & 6th) on the other, the primaries and a few of the secondaries are brown with fine green edges, as in normal birds.

793 **Indicator xanthonotus radcliffi** Hume (Kalabagh, Hazara Dist. W. Punjab) West Pakistan Orangerumped Honeyguide

nil.

794 **Indicator xanthonotus xanthonotus** Blyth (Darjeeling) Nepal Orangerumped Honeyguide 4 : 131

nil.

795 **Indicator xanthonotus fulvus** Ripley (Pfutsero, eastern Naga Hills, Assam) Nagaland Orangerumped Honeyguide

nil.

796 **Jynx torquilla torquilla** Linnaeus (Sweden) European Wryneck 4 : 99

35 : 18 ♂♂ 15 ♀♀ 2 o?

1 *Fao*, 1 *Basra, Mesopotamia* ; 1 Chitral ; 1 Koti State, 2 Simla ; 1 Shikohpur, Jullunder, 1 Ambala, 1 Dhirpur, Karnal, 1 Chandigarh, 2 Bhawalpur, Punjab ; 4 Delhi ; 1 Pithora, Sind ; 4 Kutch ; 1 Bharatpur ; 1 Maval*, 1 Hamawas Lake, Pali, 1 Ajmere, Rajasthan ; 1 Deesa, Palanpur, 1 Amreli, 1 Ajwa, Baroda ; 1 Juhu, 1 Bombay Island ; 1 Bhanupratappur, 1 Bailadila, Bastar, 1 Central Provinces ; 1 Cawnpore ; 1 Chitwan, Central Nepal. * Missing

	Wing	Bill	Tarsus	Tail
Nominate *torquilla*	♂♂ 78-90 av. 84	14-15	18-20	60-70 av. 65
(IH *ex* Witherby	83-91	from skull 14-17	19-20	61-71
	♀♀ 83-90 av. 86·7	14-15	18-20	—)
(IH *ex* Witherby	83-91	—	—	—)
himalayana	♂♂ 78, 82	14, 15	19(2)	65, 66
(IH *ex* Vaurie	81-90 av. 86	—	—	—)
chinensis	83, 84, 85, 86, —	14-15	19-20	61, 63(2), 67(2)
(IH *ex* Vaurie	♂♂ 82-87 av. 85·5	—	—	—)

797 **Jynx torquilla chinensis** Hesse (China, Tsingtao, Shantung) Chinese Wryneck

5 : 2 ♂♂ 1 ♀ 2 o?

4 Baghowni, Darbhanga, Bihar ; 1 *N. Shan States, Burma.*

These birds are slightly darker above than nominate *torquilla* and also have a more consistently rufous chin. The upperparts also show a slight wash of rufous, a character shown in specimens from Fao, Basra, and Chitral, but which have larger wings 90, 90, and 85 mm. Ticehurst (*JBNHS* **36** : 933) recorded *intermedia* Stegmann from Burma, but this is now synonymous with *chinensis*, which has also been recorded from Nepal by Fleming & Traylor (*Fieldiana*, 1964, p. 524).

797a **Jynx torquilla himalayana** Vaurie (Inshan, Wardwan Valley, Kashmir) Kashmir Wryneck

3 : 2 ♂♂ 1 ♀ (juv.)

2 Liddar Valley, 1 Haowan Village, Kashmir.

The juvenile has a large first primary *contra* tiny in adults.

798 **Picumnus innominatus innominatus** Burton (Himalayas = Sikkim) Northern Speckled Piculet 4 : 92

14 : 9 ♂♂ 5 ♀♀

2 Koti State, 2 Simla, NW Himalayas ; 1 Dehra Dun, 2 Bhim Tal, Kumaon, 1 Mornaula, Garhwal ; 2 Longview, Darjeeling, 4 Margherita, Upper Assam.

799 **Picumnus innominatus malayorum** Hartert (Gunong Ijau, Perak, Malaya) Southern Speckled Piculet **4** : 94

18 : 2 ♂♂ 16 ♀♀ (4 by plumage)

1 Lamasinghi, 3 Sankrametta, Vizagapatam Hills ; 2 Bailadila, 2 Chota Dongar, 1 Antagarh, 1 Geedam, Bastar, 1 Kuldia, Nilgiri, 2 Berbera, Puri Dist., 2 Badrama, Bamra, 1 Garguria, Simlipal Hills, Orissa ; 1 *N. Shan States* ; 1 *Shan States, Burma.*

The material available appears to show more variation than indicated in IND. HANDBOOK, but has for the moment been grouped in accordance with the distribution therein. The following comments may assist future workers.

In IND. HANDBOOK Ticehurst's *simlaensis* is identified with nominate form. In spite of the name, the type locality of *simlaensis* is further west at Murree, whence there is no material for comparison. The difference in wing size 58-61 av. 59·9 as against 55-58 av. 56·7 is small but accepted as consistent by Vaurie (1965, p. 686).

The birds available to as far east as Garhwal are brighter above but a yet unregistered male (BH/861) from Shamgong, Bhutan, has a dark head similar to those from S. India.

In those under *malayorum*, 9 females from Bastar and Orissa show in series duller upperparts than those from the north, and have the heads of the same colour. Two females (by plumage) from North Shan States and Shan States have their heads a clearer olive-green like the back, and not darker, as is required for *malayorum*—Ripley (*JBNHS* **48** : 15) noted a similar difference in one from Laukkong, E. Burma.

Three from Eastern Ghats show dark heads and may be linked either with the southern *avunculorum* (*infra*) or northeastern birds.

	Wing	Bill	Tarsus	Tail
♂♂ *innominatus*				
6 Simla, & east to Dehra Dun	56-60 av. 58·5	11-12 av. 11·8	12-14 av. 13	30-33 av. 31·3
1 Darjeeling, 2 Margherita	53, 54, 55	10-11	12	28, 29, 31
♂♂ *malayorum*				
1 Bailadila, 1 Simlipal Hills	58, 58	12, 12	12, 13	34, 30
♂♂ *avunculorum*				
1 Coonoor Ghats, 1 Wynaad, 1 Manalur, Palnis	59, 59, 56	11, 11, 12	—, 12, 14	33, 33, 31
♀♀ *innominatus*				
1 Simla, 1 Kumaon, 1 Darjeeling.	59, 58, 58	12(3)	12(3)	30, 31, 32
2 Margherita	54, 55	11, 12	13, 13	31, 32

♀♀ *malayorum*				
2 Shan States	53, 58	11, 12	13, 13	29, 34
10 Bastar & Orissa	58-60 av. 58·6	11-12 av. 11·4	12-14 av. 13·3	30-34 av. 31·2
3 Vizagapatam Hills	58, 58, 61	11, 12, 12	13(3)	30, 31, 33
♀♀ *avunculorum*				
2 N. Kanara	56, 59	11, 12	12, 13	30, 32

It will be noticed that the four (2 ♂♂, 2 ♀♀) from Margherita, Assam, have consistently shorter wings than the others except for one from Darjeeling.

799a **Picumnus innominatus avunculorum** Hartert (Nilgiris) Nilgiri Speckled Piculet 4 : 94

5 : 3 ♂♂ 2 ♀♀

1 Anshi, 1 Mankibail, N. Kanara ; 1 Coonoor Ghat, 1 Wynaad, Nilgiris ; 1 Manalur, Palnis.

The two males from Coonoor Ghat and Wynaad differ from all the others available by their darker heads marked with black spots which are absent in the single male from the Palnis.

The limited material indicates that *avunculorum* from the Nilgiris is valid and for the sake of convenience, others with dark heads from neighbouring areas are grouped with them.

The measurements are under 799.

800 **Sasia ochracea ochracea** Hodgson (Nepal) Himalayan Rufous Piculet 4 : 95

4 : 2 ♂♂ (1 by plumage) 2 ♀♀

1 Darjeeling ; 1 Dickchu, N. Sikkim ; 1 Dibrugarh, 1 Sadiya, Upper Assam.

	Wing	Bill	Tarsus	Tail
2 ♂♂	52, 54	12, 12	13, 13	26 +, —
2 ♀♀	53, 54	13, 13	13, 14	20, 23
	(IH 52-53	from skull 12-15	14-15	22-24)

The underparts of the two females are deeper rufous than in the others, including the male from Dibrugarh. In four yet unregistered specimens from Bhutan (1 o ? 3 ♀♀) the unsexed bird which has the gold front of the male, is paler, than the females, both above and below.

The statement in the FAUNA (4 : 96) repeated in IND. HANDBOOK (4 : 175) that the forehead of the female is almost concolorous with the crown is not correct, for the crown is dark olive-grey and forms a very distinct cap. This cap is least distinct in the four males referred to herein.

801 **Sasia ochracea reichenowi** Hesse (Burma, type from Thayet Chaung, Tenasserim) Burmese Rufous Piculet **4**: 97

4 ♂♂ (1 by plumage)

1 Bagho Bahar, 1 Laisingh, Cachar; 1 Laikinsaw, Khasia Hills; 1 *Kamaing, U. Burma.*

Sp. No. 10380 from Cachar is marked ♂, but has the rufous forehead of the female and may be in juvenile plumage. Though they show some variation of colour among themselves, all of them are more rufous, less olive-green above, and can be separated from those from Bhutan. Three are marked *querulivox* Baker by Sálim Ali and it is possible that this race may be worth retaining. The few specimens show differences in colour, but in the absence of suitable series from any one place it is not possible to comment on them.

802 **Micropternus brachyurus humei** Kloss (Kumaon bhabar) Western Rufous Woodpecker **4**: 64

nil.

803 **Micropternus brachyurus phaioceps** Blyth (Arrakan) Eastern Rufous Woodpecker **4**: 63

26 : 11 ♂♂ (2 by plumage) 11 ♀♀ 4 o ?

When described the bird was said to be found in 'India proper extending eastwards to Tipperah and Arrakan and the type locality has finally been restricted to Arrakan. In the meantime *mesos* was described (Kloss 1918) from Orissa (Cuttack), Calcutta, and Bengal. This is not accepted in IND. HANDBOOK, but the material available falls into separate groups. Though the differences are insufficient to permit any very decisive conclusion, I am for the moment drawing attention to them.

(*a*) 5 : 2 ♂♂ (1 by plumage) 3 o ?

1 *Lower Chindwin*, 1 *Bhamo*, 2 *S. Shan States*, 1 *Taunggyi, Burma.*

These five extralimital birds from Burma are an appreciably brighter chestnut above and larger than those from the adjacent areas of Assam and Bengal. Considering the final restriction of type locality to Arrakan, I presume that they are *phaioceps*. They however show differences among themselves which I am unable to clarify.

Sp. 10199 (Capt. H. Wood, R.E.) is marked Bhamo, *South* Shan States, while the only Bhamo on the maps available is in *North* Shan States. No. 10201 (♂ by plumage) and 10202 o ? were both collected by S. S. Lightfoot on 30 December 1912 in Southern Shan States. The unsexed bird without any red on the cheeks, has the head and neck buffish with narrow chestnut centres which leaves the area pale coloured and very different from the second collected on the same day and from the others available and approaches *fokiensis* (Swinhoe) as described in La Touche's HANDBOOK OF BIRDS OF EASTERN CHINA, Pt. 2 : 26, though the wings are smaller (129-135). No. 10200 from Taunggyi, further south, is very heavily barred on the upperparts, a character shared almost to the same extent by 10202. All have their chins prominently streaked on a buff background. An unregistered ♂ + [wing 128 from Mangdechu, Bhutan (BH 730)] is also similarly coloured above.

In all these birds the primary shafts are pale and concolorous. Their chins vary to some extent but the centre of the feather, which is brownish like the abdomen, has a relatively wide buff border on both sides.

(*b*) 8 : 4 ♂♂ 3 ♀♀ 1 o ? (juv.)

1 Sevoke, 1 Darjeeling, Bengal ; 1 Goalpara, 2 Dibrugarh, 1 Lasmyah, Cachar, 1 Rema T. E., S. Sylhet, 1 Wahlong, Assam.

These birds are much darker above and below than those under (*a*) and have almost unmarked throats, except for the two westernmost from Darjeeling which in this respect resemble birds in group (*c*). The juvenile from Wahlong, collected by Stuart Baker in 1906, approaches group (*a*) in its lighter colour and streaking on the chin.

(*c*) 11 : 5 ♂♂ (1 by plumage) 6 ♀♀

1 Berbera, Puri Dt., 1 Chahala, Simlipal Hills, 1 Badrama, Bamra, Orissa; 1 Rajaputtee, Saran, 5 Baghowni, 1 Narbar, Madhubani, Bihar ; 1 no data.

These form another group in which the chins are marked with broader streaks with less buff at the sides, and which in series are distinctly paler all over than (*b*).

Three individuals, a ♂ from Badrama, Orissa, a ♀ from Baghowni, Dharbhanga, and 1 unsexed from Rajaputtee, Saran, are brighter bay in colour and resemble (*a*) from Burma. Stuart Baker (1919, *Ibis*, p. 199) referred to the same trait in specimens from Ceylon, Travancore, Ootacamund and Madras, and Nepal and Assam, and described the character as valueless.

(*d*) 1 ♀ Bastar, M.P.

(*e*) 1 ♀ Anantgiri, 3000′ Eastern Ghats.

The 2 southernmost females, from Bastar and Anantgiri, have darker centres to the feathers of the throat, approaching the squamation of southern *jerdonii*.

As the sexes show no consistent difference in size, they are measured together :

	Wing	Bill	Tarsus	Tail
(*a*) Burmese (5)	126-130 av. 128	25-26	20-24	62-66 av. 64·8
(*b*) Assam (5)	115-125 av. 118	23-25	21-23	55-66 av. 61
Darjeeling (2) (*a* & *b*	117-130 av. 125	22-24	—	—)

(IH Central Nepal,	127-133	—	—	61-68
Sikkim and				Biswas
Assam	119-130	26-30	ex Ticehurst)	
(*c*) Bihar and Orissa	118-125 av. 122	24-27	22-23	54-65 av. 60
(*d*) Bastar, M.P. ♂	121	25	22	61
(IH Bastar and Orissa	121-126	26-29	21-22	58-65)
(*e*) 3000′ Anantgiri, Vizagapatam Dt., ♂	118	26	22	58
jerdonii ♂♂	121-130 av. 125·4	25(3), 26,—	22-25 av. 23	60-71 av. 62
(IH northern	117-134	from skull 26-30	*c.* 24	61-65)
(IH Kerala	117-121	from skull 26-29	—	60-63)
jerdonii ♀♀	115-128 av. 125	23-26 av. 25	22-25 av. 23	58-64 av. 61
(IH northern	117-130	from skull 27-30	*c.* 24	60-65)
(IH Kerala	117-120	27-28	—	62-63)

804 **Micropternus brachyurus jerdonii** (Malherbe) (Indian Peninsula; restricted to Travancore) Southern Rufous Woodpecker 4 : 65

16 : 5 ♂♂ (1 by plumage) 9 ♀♀ 2 o ?

2 Pimpri, Surat Dangs; 2 Borivli, 1 Andheri, Bombay; 1 Dorli, Ratnagiri; 1 Kadra; 1 Yellapur, 1 Karwar, N. Kanara; 1 Antarsante, SW. Mysore; 1 Parambikolam, Cochin; 1 Thekadi, 1 Thattakad, 2 Trivandrum, Travancore; 1 Shevaroy Hills, Salem, Tamil Nadu.

This series from western India covers the accepted range of *jerdonii*, but in the northern birds from the Surat Dangs south to Ratnagiri the squamations on the chin and throat are obsolete and almost absent while they are much more prominent further south. In all however the feathers of the chin and throat are more squarish and not elongated as in those under *phaioceps.*

The single female No. 10020, from Shevaroy Hills, 4000 ft., is paler and earthy brown all over, while another female No. 10222 from Parambikolam, 1650 ft., Cochin State, is appreciably darker than all the others. Three others from Travancore further south, from the low country, do not have this character and are similar to those from North Kanara. It is possible that distinct populations exist in isolated biotopes.

The measurements are under No. 803.

806 **Picus squamatus flavirostris** (Menzbier) (Murghab, Transcaspia) Transcaspian Scalybellied Green Woodpecker 4 : 8

nil.

807 **Picus squamatus squamatus** Vigors (Himalayas, restricted to Simla-Almora Districts) Himalayan Scalybellied Green Woodpecker **4** : 7

34: 20 ♂♂ (1 by plumage, 4 juv.) 14 ♀♀ (5 juv.)

1 Kilia Drosh, 5 Chitral, N.W.F.P.; 1 Kashmir; 2 Dalhousie, Punjab, 1 Nichar, 7000′, 1 Himalayas; 12 Simla, 2 Mussoorie, 1 Mouna Khal, 1 Ramni, Garhwal, 2 Dakhuri, 1 Dinopani, 1 Pithoragarh, 1 Ramgarh, Nainital, Kumaon, 1 Bodiar (?), 1 no data.

	Wing	Bill	Tarsus	Tail
16 ♂♂	159-166 av. 162·6	40-44 av. 42·4	29-32 av. 30·5	99-118 av. 105.8
9 ♀♀	153-164 av. 160·2	36-42 av. 40·7	27-32 av. 30	92-115 av. 109
	(♂♀ 155-172	27-33	*c.* 27	127-136)

The bill is much larger and the tail smaller than indicated in FAUNA and repeated in IND. HANDBOOK.

In the males there is some difference in the nature of the red on the head, and two, Simla (9 Oct.) and Kumaon (1 May), have a yellowish wash on the underparts.

Males (5) and females (4) obtained in September (1) and October (8) show more green on the upperparts than the others—December (2), February (1), March (4), April (2), May (2), June (1) and July (1).

808 **Picus myrmecophoneus** Stresemann (Himalaya and Central India) Little Scalybellied Green Woodpecker **4** : 10

16 (details below)

According to IND. HANDBOOK (4 : 184) no subspecies are acceptable but the material available does show differences :

(*a*) 10 : 7 ♂♂ (1 juv.) 3 ♀♀

1 Ketti, Nilgiris; 1 Shembaganur, Palnis ; 1 Aramboli, 1 Thekkadi, Travancore; 1 Chitteri Range, Salem; 2 Amraoti, 1 Darba, Bastar; 1 Pilibhit Terai; 1 Bankulwa Morang, Nepal.

These birds, presumably including topotypes, have margins to the feathers of the underparts darker than in (*b*). Birds from Bastar and further south have the darkest upperparts.

The juvenile ♂ has very scattered red on the head.

(*b*) 3 ♂♂

1 Jagadhri, Ambala, 1 Ladhwa, Karnal, Punjab ; 1 Sanchi, Bhopal, C.I.

These birds, including two marked adult by the collector, are paler above than (*a*), and the feathers of the underparts lack the black scalloping.

(*c*) 3 : 2 ♂♂ 1 ♀

2 *Kani, Lower Chindwin* ; 1 *Pakokku, Magwe, Burma.*

In addition to being larger, their rumps and upper tail-coverts are greenish yellowish and show no orange. Both males have their heads orange-red (as in one *viridanus* q.v.) and not crimson (as in Indian birds).

As the sexes show no differences in size, their measurements are placed together :

	Wing	Bill	Tarsus	Tail
(*a*)	124-133 av. 130·6	30-31	25-26	78-93 av. 86
(*b*)	123, 128, 132	30, 31(2)	25(2), 26	82, 84, 91
(*c*)	137, 138, 138	30(3)	25(2), 26	90, 90, 96
(IH ♂♂	124-138 once 142	from skull 28-38	22-26	76-97
♀♀	124-134	from skull 25-35	21-26	78-93)

Though the colour differences in the small series in Group (*c*) may be of no significance, the birds are distinctly larger than the others.

EL **Picus vittatus viridanus** Blyth (Arakan) Burmese Scalybellied Woodpecker **4 : 12**

4 : 1♂ 3 ♀♀

1 *Sandoway*, 1 *Bassein*, 1 *S. Irrawady*, 1 *Ataran, Amherst Dist., Burma.*

Wing	Bill	Tarsus	Tail
138(2), 141, 143	33(2), 34,—	27(3), 28	97, 102, 102, 106
(125-148 almost invariably over 132	29-36 generally over 32	*c*. 26	92-104)

There are no streaks on the chin, throat and upper breast, which are strongly washed with brownish and tinged with greenish. This together with the longer tail (which was referred to by Blyth) separates them distinctly from Group (*c*) under No. 808.

The Smithsonian Institution was good enough to lend me a series of *P. v. viridanus* collected at Ban Khlua Klang, Prachuap Khiri Khan, Thailand, and so marked by Deignan. These however do not agree with the above specimens, lacking the ochraceous tone, and I am prompted to draw attention to Paynter's recent note (*Bull. B.O.C.* **90** : 118, 1970) regarding a female obtained in Khulna District, Sunderbans, which he says does not agree with *viridanus*, as it has no streaks on the upper breast, throat, and neck, and suggests that it is closer to *eisenhoferi*. U.S.N.M, Sp. No. 449438 from Akyab, Arakan, north of those in the B.N.H.S. collection, appears to be similar, but is again quite different from a pair marked *eisenhoferi* by Deignan. I cannot help feeling that there is considerable confusion relating to the identity and distribution of the several races *viridanus*, *eisenhoferi*, *weberi*, *eurous*, and *connectens*, said to occur over a very restricted area in Thailand, and that an extensive reappraisal is necessary.

The single male has the head orange-red as in two *myrmecophoneus* from Kani, Lower Chindwin (q.v.), and Mr. Derek Goodwin of British Museum (Natural History) to whom it was sent stated that one specimen of *P. vittatus*, a male from Pulau Langkawi, Malay Peninsula (B.M. No. 1936.4.12.586) has its head nearly the same colour.

EL **Picus canus jessoensis** Stejneger (Sapporo, Hokkaido, Japan) Japanese Greyheaded Woodpecker

6 : 3 ♂♂ 3 ♀♀ (1 juv.)

All *Peking, China*, collected by Major H. J. Walton in 1901.

	Wing	Bill	Tarsus	Tail
♂♂	143, 144, 146	35, 36,—	24, 26, 27	90, 96, 96
♀♀	juv. & mltg.	32, 35	25, 26	93

The juvenile has a slight brownish wash all over. All the males have different coloured heads ranging from all-grey to largely black after the red forehead.

Birds from this area were described as *zimmermanni* by Reichenow but have been synonymised with this form (1965, Vaurie, p. 693).

809 **Picus canus sanguiniceps** Baker (Himalayas, Simla-Almora Dist.) Indian Blacknaped Green Woodpecker 4 : 13

11 : 6 ♂♂ 5 ♀♀ (1* juv.)

1 Siroli, 1 Koti State, NW Himalayas, 4 Simla ; 2 Mussoorie, 1* Mornaula, 1 Yoshimath, Garhwal, 1 Bhimtal, Kumaon, U.P.

	Wing	Bill	Tarsus	Tail
6 ♂♂	155-166 av. 160·6	41-42	29-31	113-123 av. 118
	(IH *ex* Greenway 157-165 av. 160·6	—	—	—)
	(IH *ex* Biswas 145-152	40-44	—	98-108)
4 ♀♀	158, 159, 160(2)	40(2), 41, 42	29, 30(2), 31	108, 110, 116, 120
	(IH *ex* Biswas 145-154	38-44	—	100-116)

810 **Picus canus gyldenstolpei** Baker (Sadiya, north Lakhimpur, Assam) Assam Blacknaped Green Woodpecker 4 : 15

28 : 12 ♂♂ (2 juv.) 16 ♀♀ (2 juv.)

1 Chalna Khel, 1 Tribine, Nepal ; 1 Rinchingpong, 1 Rangpo, Sikkim ; 3 Longview, Darjeeling, 1 Goma Reserve, Goalpara, 2 Sadiya, Upper Assam, 2 Gusyong, 2** North Cachar, 1* Roopchena, 1 Bagho Bahar, Cachar, 1 Mishmi, Assam ; 1 *Kalewa, Upper Chindwin,* 1 *Kani, Lower Chindwin,* 1 *Fort White, Chin Hills* ; 1 *SE.* of *Maymyo, Mandalay Dt.,* 1* *Hsipaw, N. Shan States* ; 1 *Pakokku, Arakan,* 1 *Toungoo,* 3 *Thayetmyo,* 1 *Ataran.*

		Wing	Bill	Tarsus	Tail
Assam & Bengal	4 ♂♂	—, —, 138, 141	35(2), 37, 40	27(4)	93, 95, 96, 101
	8 ♀♀	138-149 av. 142	33-37 av. 35	27-29	91-112 av. 98
Burma	♂♂	139-153 av. 148	35-42 av. 37	27-30	97-110 av. 104·6
	♀♀	148-156 av. 150·4	35-37 av. 36	27-29	99-112 av. 104·4

This group is separated from *sanguiniceps* by the golden sheen on the upperparts and its smaller size.

There is some variation in colour but it is not possible to separate Indian specimens from those from Burma which are accepted as identical with *hessei* Gyldenstolpe (Northern Siam) and which is an older name. I am however leaving them as *gyldenstolpei* until a definite decision is taken.

Two (Nos. 21144 and 21145) from Sikkim are a darker green below and agree with 7 unregistered birds from Bhutan. However they (9) are the freshest skins and this may be the reason.

The juveniles, which can be separated by the broader and rounder tipped first primary, are duller green above and show more brown than green below. The tail is *less* distinctly barred (*contra* IND. HANDBOOK **4**: 186) than in the adults and only one, a female from Roopchena, Cachar (4 July 1893) has traces of barring on the lower belly.

811 **Picus canus kogo** (Bianchi) (Bartschou, affluent. fl. Nomu-tschu, tribut. fl. Mekong sup.) Tibetan Blacknaped Green Woodpecker

nil.

EL **Picus erythropygius nigrigenis** (Hume) (No locality) Redrumped Green Woodpecker **4**: 22

3 ♀♀

1* *Fort White, Chin Hills*, 1 *Hsipaw, North Shan States*; 1 *Taunggyi, Yawnghwe, Burma*.

	Wing	Bill	Tarsus	Tail
♀♀	146, 156, 162*	31, 32, 34*	29*, 30, 30	—, 104, 117*
(♂♀	147-157	30-35	30-31	99-114)

The birds from Fort White and Hsipaw slightly extend the northern limits of the species which are said to be Tounghoo and Karenni (FAUNA) repeated in Peters's CHECKLIST (6 : 138) and extended to 'Foothills of Maymyo' by Smythies (1940, BIRDS OF BURMA, p. 295).

No. 9957* from Fort White, Chin Hills, is the largest and with rump brighter and larger than in the others.

EL **Picus viridis karelini** Brandt (Astarabad, northern Iran)

1 ♂ *Bandar-e-Gaz, W. Astarabad, Caspian Province, Iran.*

Wing 158; bill 40; tarsus 33; tail 98.

The subspecific identification is based on the distribution in Peters's CHECKLIST. Vaurie (1965: 688) has synonymized it with nominate *viridis*.

812 **Picus flavinucha kumaonensis** (Koelz) (Kathgodam, Naini Tal Dist., U.P.) Kumaon Large Yellownaped Woodpecker

2 : 1 ♂ 1 ♀

2 Ranibagh, Kumaon, U.P.

	Wing	Bill	Tarsus	Tail
♂♀	183, 179	40, 37	30, 29	130, 132

(IH 'Wing over 180 ; tail over 131 mm—Biswas ').

813 **Picus flavinucha flavinucha** Gould (Himalayas, Darjeeling) Eastern Large Yellownaped Woodpecker 4 : 23

20 : 11 ♂♂ (1 juv.) 9 ♀♀ (1 juv.)

1 Chahala, Simlipal Hills, Orissa ; 1 Digla, 1 Bijaypur, Nepal ; 1 Darjeeling, 5000′, 1 Kurseong Division, 1 Singtam, Tista Valley, 1 Temi, 1 Gangtok, Sikkim ; 1 Tegu, Lohit Valley, 1 Margherita, Upper Assam, 1 Naga Hills, 1 N. Cachar, 2 Bagho Bahar, 1 Roopchena, Cachar, Assam ; 1 *Lower Chindwin*, 1 *Loi Kaw*, *N. Shan States*, 1 *Upper Burma*, 1 *Sandoway Dt.*, 1 *Ataran*, *Amherst Dt.*, *Burma*.

	Wing	Bill	Tarsus	Tail
♂♂	158-171 av. 165·5	37-42 av. 38	27-30	112-122 av. 117
	(IH 163-177	from skull 40-45	27-32	114-127)
♀♀	155-170 av. 165·5	35-40 av. 38	27-30	105-115 av. 112
	(IH 166-173	from skull 37-42	29-30	113-135)
1 ♀ Ataran*	146	37	28	109

The ♂ and ♀ from Nepal have the shortest wing.

* Sp. No. 9971, the female from Ataran, Amherst Dist., Burma, has the rufous barring extending to the tips of the primaries, a character of *ricketti* (Biswas, 1954, *Ibis*: 214). Apart from the fact that Ataran is far from the habitat of this race, another (♂ No. 9963) from Bagho Bahar, Cachar, has similar wing quills, and is marked ' juvenile ' by the collector, and the barred primaries would appear to be shared with adjacent races in juvenile plumage.

The specimens available show differences in colour but it is not possible to localize them.

814 **Picus chlorolophus simlae** Meinertzhagen (Dehra Dun) West Himalayan Small Yellownaped Woodpecker 4 : 18

6 : 3 ♂♂ 3 ♀♀

1* Simla, 1 Konda Ghat, Patiala State ; 2 Dehra Dun, U.P. ; 1* Mouna Khal, Garhwal ; 1* Hathibari, Nepal.

	Wing	Bill	Tarsus	Tail
♂♂	140, 140*, mltg.*	22*, 28*, 29	21*, 23, 25*	mltg.*, 93+, 95*
(IH *ex* Biswas	135-146	from skull 30-33	—	96-104)
♀♀	134*+, 144, 148	24*, 30, 31	22, 22, 25*	mltg.*, 104, 105

The 3 marked with an asterisk (2♂♂ 1♀) have greyish and not green heads and presumably represent an immature phase. The breasts are also duskier, less greenish than in the others.

815 **Picus chlorolophus chlorolophus** Vieillot (Bengal) East Himalayan Small Yellownaped Woodpecker **4 : 17**

26 : 12♂♂ 14♀♀(1 by plumage)

1 Vizagapatam Hills, 1 Jeypore Agency, Vizagapatam; 1 Badrama, Bamra, 1 Koira, Bonai, 1 Chahala, 2 Gurguria, Simlipal Hills, Orissa; 1 Hazaria, Patherghata, Bihar; 1 Longview, Darjeeling, 2 Kurseong Div.; 1 Martam, Rongni Valley, Sikkim; 1 Buxa, 1 Goma Reserve, Goalpara, 1 Denning, Lohit Valley, 1 Abor Expedition, 1 Dibrugarh, 1 Naga Hills 8000′, 2 Rema T.E., S. Sylhet, 2 N. Cachar, 2 *Kamaing, Upper Burma*, 1 *Mansum* (*Chindwin Exp.*), 1 *Nindon Yoma Pass, Thayetmyo, Burma.*

The northern birds show more green on the underparts, and the Burmese specimens cannot be separated by size or colour except that none of them have any green tinge on the breast, which is apparently an adult character in Indian birds. Females from Vizagapatam Hills (one, a very poor specimen) have their wings 123 and 124 mm, and together with a third female from Simlipal Hills (wing 126) lack the yellowish on the back visible in all the others of both sexes.

	Wing	Bill	Tarsus	Tail
Burmese				
4 ♀♀	131, 132(2), 133	25(2), 27, 30	22(2), 23(2)	90, 91, 92, 96
NE Indian				
♂♂	127-136 av. 132	25-27	20-23	90-94
♀♀	128-135 av. 130	25-28	20-23	87-95 av. 92
Bihar & Orissa				
♂♂	128, 132, 133	26(2), 27	21(2), 23	92(2), 95
♀♀	126, 130(2)	23, 25(2), 26	20-22	85(2), 90, 92
(♂♀	126-142	21-28	22-23	74-94)

Excluding two green-backed females referred to above, this race is well distinguished from *chlorigaster* not only by the absence of the bronze sheen on the back, but by the fact that in the male the red on the forehead, lores, and nape encircles a large patch of green, which area is all red in the southern birds. With this character, the birds from Vizagapatam Hills and Mayurbhanj, Orissa, should be of this race and not *chlorigaster* as stated in IND. HANDBOOK (**4** : 194). Whistler in the Eastern Ghats report (*JBNHS* **37** : 287) also identified one of the specimens as of the nominate race but his reference to the 'golden sheen' on the back of Himalayan birds is confusing; this may perhaps be better termed a yellowish wash.

816 **Picus chlorolophus chlorigaster** Jerdon (Southern India) South Indian Small Yellownaped Woodpecker 4 : 19

18 : 11 ♂♂ (1 by plumage) 7 ♀♀

2 Songadh, Navsari, 1 Malegaon, Surat Dangs ; 1 Anshi Ghat, 1 Santgal, 2 Karwar, 2 North Kanara ; 1 Somvarpet, Coorg ; 1 Wynaad ; 1 Parambikolam, Cochin ; 2 Manalur, Palnis ; 2 Thattakad, North Travancore ; 1 Cape Comorin ; 1 no data.

	Wing	Bill	Tarsus	Tail
♂♂	118-126 av. 122	24-27 av. 26	20-22	76-86 av. 81·5
	(IH 120-128	from skull 26-32	20-24	78-89)
♂♂	119-127 av. 120·7	23-26 av. 24	20-22	78-83 av. 80
	(IH 119-128	from skull 26-30	20-23	77-84)

Ten males (1 by plumage) have a varying amount of red on the head. Another (No. 20001) from Palni Hills has no red on the head but is marked ♂, and is probably an error in sexing, having no character which would indicate a juvenile. A few specimens show a few white spots on the lower back.

817 **Picus chlorolophus wellsi** Meinertzhagen (Ceylon) Ceylon Small Yellownaped Woodpecker 4 : 20

1 ♂ Bibile, Ceylon.

Wing	Bill	Tarsus	Tail
117	22	20	77
(IH 115-123	from skull 24-25	19-20	78-86)

(*to be continued*)

Contribution to the Flora of Tirap Frontier Division

BY

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[*Continued from Vol.* **70** (1) : 94]

SOLANACEAE

Datura metel Linn.

A shrub in flowers ; scarce. Margharita-Jairampur, Oct. 1959, *Rao* 19910.

D. suaveolens Humb. & Bonpl. ex Willd.

A shrub with white flowers ; cultivated ; common. Wakka, July 1961, *Deb* 26503.

Lycopersicon lycopersicum (L.) Karsten. Tomato

A herb on moist soil with deep yellow flowers. An escape of cultivation. Chenglang, March 1958, *Murthy* 12901.

Lycianthes macrodon (Wall. ex Nees) Bitter

A herb in flowers with enlarged calyx in fruits. Forms societies as an undergrowth ; common. Raho-Wakka, July 1961, *Deb* 26406 ; Langsang forest, June 1961, *Deb* 26139 ; Pungchow, July 1961, *Deb* 26622.

L. pachypetala (Spreng.) Bitter

A shrub with blood red fruits ; scarce. Nampong-Pangsupass, March 1958, *Murthy* 12992.

L. subtruncata (Wall. ex Dunal) Bitter

A herb with woody base in whitish or bluish white flowers ; rare. Longsek hillock, 1500 m, June 1961, *Deb* 25735.

Pauia belladonna Deb et Dutta

A herb with perennial base. A monotypic genus published by the authors in *Ind. For.* **91** (6) : 363. 1965. Wakka, July 1961, *Deb* 26422.

The genus is named in honour of the late Rev. Dr. H. Santapau, Director, Botanical Survey of India. The specific name is chosen after Indian Belladonna for its apparent similarity in general appearance. It contains an alkaloid and deserves thorough chemical investigation for medicinal properties.

Solanum indicum Linn.

A shrub with white flowers ; scarce. Pungchow, July 1961, *Deb* 26582.

S. kurzii Brace ex Prain

A shrub with white flowers ; common. The fruit is used by local people as a medicine in stomach disorder ; Nampong-Pangsupass, March 1958, *Murthy* 13001 ; Chenglang-Khela, March 1958, *Murthy* 12927, 12943 & 12944 ; Lailongsong, June 1961, *Deb* 25794 ; Margharita-Jairampur, Oct. 1959, *Rao* 19935.

CONVOLVULACEAE

Argyreia capitata (Vahl) Choisy

A twiner with red fruits ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20260 ; Jairampur, Oct. 1959. *Rao* 19978 ; Khela, March 1958, *Murthy* 12985.

A. roxburghii Choisy

A climber with deep chocolate coloured flowers ; rare. Kheti-Tinchha, Aug. 1958, *Panigrahi* 14617.

Ipomoea kingii Prain

A climber with white flowers ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20289 ; Jairampur, Oct. 1959, *Rao* 19981 ; Pungchow-Niausa, July 1961, *Deb* 26648.

Merremia mammosa (Lour.) Hall. f.

A large twiner with white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19915 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20166.

Porana racemosa Roxb.

A twiner with white flowers ; scarce. Soha village, 1850 m., Oct. 1959, *Rao* 20353.

SCROPHULARIACEAE

Hemiphragma heterophyllum Wall. ex Tent.

A herb forming societies ; common. Noglo, June 1961, *Deb* 26331,

Scoparia dulcis Linn.

A herb with white flowers ; very common. Jairampur, Oct. 1959, *Rao* 19977.

Torenia cordata (Griff.) Dutta

A small herb with pinkish violet or deep-violet flowers in pure stands in open ground ; very common. Tipang, June 1961, *Deb* 25709.

T. vagans Roxb.

A prostrate herb with bluish pink or violet flowers ; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20090 ; Kothong, June 1961, *Deb* 26067.

T. violacea (Azaola ex Blanco) Pennell

A herb with violet flowers ; common. Jangkeng village, June 1961, *Deb* 25850.

Vandellia antipoda (L.) Yamazaki

A small prostrate herb ; common. Namchick, 152 m, Oct. 1959, *Rao* 20180 ; Deomali, Oct. 1959, *Rao* 20314 & 20315 ; Lailongsong, 510 m, June 1961, *Deb* 25817 ; Khonsa-Laju, June 1961, *Deb* 26005.

V. crustacea (L.) Benth.

A prostrate herb with bright mauve flowers ; common. Jairampur, Oct. 1959, *Rao* 19969 & 20002.

V. mollis Benth.

An annual with white flowers ; rare. Jangkeng village, June 1961, *Deb* 25870 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20084 ; Jairampur, Oct. 1959, *Rao* 19976 ; Lunwa, July 1961, *Deb* 26644.

V. pusilla (Willd.) Yamazaki

A diffused herb with green flowers ; rare. Longhoi-Rusa, Sept. 1958, *Panigrahi* 16763.

ACANTHACEAE

Mackaya neesiana (Wall.) Das

An undershrub with lilac red flowers ; rare. Laju hills, 1575 m, Aug. 1958, *Panigrahi*, 14647.

Phlogocanthus tubeflorus Nees

A shrub with pink or blood red flowers ; common. Chennhang, June 1961, *Deb* s.n.

Strobilanthes coloratus (Nees) T. Ander.

An undershrub with pink flowers; common. Nampong-Pangsupass, 300-1100 m, Oct. 1959, *Rao*, 20160; Banfera, July 1961, *Deb* 26703.

S. glabratus Nees

A shrub with violet flowers; common. Uptil now this is known to occur in Khasia and Jaintia hills only. The present record extends its distributions to NEFA. Jangkeng village, June 1961; *Deb* 25853.

S. echinata Wall. ex Nees

A shrub with deep violet flowers; scarce. Raho-Vokanoska, Aug. 1958, *Panigrahi* 16836.

S. helictus R. Ander.

An undershrub with yellow flowers; scarce. Raho-Vokanoska, Aug. 1958, *Panigrahi* 16838.

S. pentstemonoides (Nees) T. Ander.

An undershrub with white flowers; scarce. Jadua-Banfera, July 1961, *Deb* 26669.

Thunbergia coccinea Wall.

A climber with red flowers; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20156; Chenglang, 600 m, March 1958, *Murthy* 12931; Chennhang, June 1961, *Deb* 26216.

T. grandiflora (Roxb. ex Rottl.) Roxb.

A large climber with bluish white flowers; common. Deomali, 116m, Oct. 1959, *Rao* 20307; Deomali, June 1961, *Deb* 25896.

GESNERIACEAE

Aeschynanthus bracteata Wall. ex DC.

An epiphyte with blood red flowers; rare. Noglo, June 1961, *Deb* 26346.

A. gracilis Parish ex C. B. Clarke

An epiphyte with fruits on *Litsea monopetala* Pers.; scarce. Longsek hillock, 1500 m., June 1961, *Deb* 25751.

A. parasiticus (Roxb.) Wall.

A. grandiflorus (D. Don) Spreng.

An epiphyte with flowers, scattered. Chennhang, June 1961, *Deb* 26217; Kothong, June 1961, *Deb* 26028.

A. hookeri C. B. Clarke

An epiphyte with red flowers; scattered. Chegum-Wakka, July 1961, *Deb* 26482; Chennhang, June 1961, *Deb* 26266; Pungchow-Niausa, July 1961, *Deb* 26647.

A. maculatus Lindl.

An epiphyte with red flowers; common. Rusa-Bimalpur, Oct. 1958, *Panigrahi* 16921; Namchick, Oct. 1959, *Rao* 20169.

A. maculatus Lindl. var. **stenophylla** C. B. Clarke

An epiphyte with small red flowers; rare. Chennhang, June 1961, *Deb* 26181.

A. masoniae Kurz

A creeper on rocks, with red flowers; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20157.

A. philippinensis C. B. Clarke

An epiphyte with solitary, blood red flower with long peduncle; scattered. Raho-Wakka, July 1961, *Deb* 26424.

A. superba C. B. Clarke

An epiphyte with flowers with pinkish, brown or deep red streaks; scarce. Khela-Khonsa, Aug. 1958, *Panigrahi* 14481; Chenglang-Khela, Oct. 1959, *Rao* 20270.

Boeica filiformis C. B. Clarke

A herb in moist situations in the ground floor of the forest; flowers small, pink; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20022; Jadua, July 1961, *Deb* 26681; Lailongsong, 510 m, June 1961, *Deb* 25825.

Boea multiflora R. Br.

A herb in fruits. In moist places. Lailongsong; 510 m, June 1961, *Deb* 25828.

Chirita oblongifolia (Roxb.) Sinclair

C. acuminata R. Br.

A succulent herb with yellowish white flowers; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20020.

C. hookeri C. B. Clarke

A herb with yellowish white flowers with grey lines inside the corolla; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20079.

C. macrophylla Wall. var. **macrophylla**

A succulent herb with violet flowers; common. Jangkeng village, June 1961, *Deb* 25849; Raho-Wakka, July 1961, *Deb* 26449.

C. macrophylla Wall. var. **tirapensis** (Panigr.) Deb et Dutta

Comb. & Stat. nov.

Basionym: *Chirita macrophylla* Wall. subsp. *tirapensis* Panigr. in *Bull. Bot. Soc. Bengal* 21(1): 32, 1967.

A herb with bluish purple or violet tinged flowers. This is reduced here to a variety as it does not deserve a higher taxonomic position on the basis of taxonomic differences, from the type variety. Most of the differences enumerated by the author (l.c.) are of no taxonomic significance. Glabrous stem and lesser lobation of the calyx only appear to stand as the difference. Being the only flowering material available for describing the new taxon, *Deb* 26312 treated as paratype should have been treated as the holotype in place of *Panigrahi* 14795 which does not have any flower.

C. polyneura Miq. var. **thomsonii** C. B. Clarke

A herb with violet tinged flowers. Khonsa-Laju, June 1961, *Deb* 25979.

C. pumila D. Don

A herb with violet flowers; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20071; Chenglang-Khela, Oct. 1959, *Rao* 20262; Chennhang, June 1961, *Deb* 26179.

C. urticaefolia Buch.-Ham. ex D. Don

A tall herb with yellow flowers; common. Namchick-Chenglang, Oct. 1959, *Rao* 20212.

Loxostigma griffithii (Wight) C. B. Clarke

A herb with violet flowers. Noglo-Laju, June 1961, *Deb* 26375.

Didymocarpus punduanus Wall. ex DC.

A herb about 30 cm in height in white flowers; scarce. Jangkeng village, June 1961, *Deb* 25851, Kanubari, July 1961, *Deb* 26760.

Lysionotus serrata D. Don

An epiphytic shrub in violet-pink or bluish-pink flowers; common. Raho, July 1961, *Deb* 26384; Longsek hillock, 1500 m, June 1961, *Deb* 25738 & 25750; Wakka, July 1961, *Deb* 26542; Jadua, July 1961, *Deb* 26659; Chennhang, June 1961, *Deb* 26276.

L. turnifolia DC.

A shrub in pinkish white flowers ; common. Khonsa-Kheti, Aug. 1958, *Panigrahi* 14515 ; Chegum-Wakka. July 1961, *Deb* 26492.

Rhynchotechum ellipticum (Wall. ex Dietr.) A. DC.

An undershrub in small reddish or pink red flowers. Forms undergrowth in the forest ; common. Jairampur, Oct. 1959, *Rao* 20001 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20023 ; Pungchow, July 1961, *Deb* 26572.

OROBANCHACEAE

Aeginetia indica Linn.

A light pinkish coloured root parasite with whitish violet flowers, with long pedicel ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20287 ; Soha village, Oct. 1959, *Rao* 20368.

GERANIACEAE

Geranium nepalense Sw.

A diffused herb, with long peduncled orange coloured flowers ; scarce. Raho, July 1961, *Deb* 26383.

BALSAMINACEAE

Impatiens acuminata Benth.

A small herb in violet or pinkish-red flowers, in moist places in diffused light. Namsang-Soha, Oct. 1959, *Rao* 20341 ; Khonsa-Laju, June 1961, *Deb* 26004 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20080.

I. angustiflora Hook. f.

A herb with violet or yellow flowers. Forms societies in moist and shaded regions ; common. Raho-Wakka, July 1961, *Deb* 26409 ; Khonsa-Laju, June 1961, *Deb* 25986.

I. assamica Brace

A herb with violet flowers. Banfera, July 1961, *Deb* 26710.

I. bella Hook. f. & Thoms.

A perennial herb with whitish pink to red flowers ; scarce. Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16964.

I. drapanophora Hook. f. & Thoms.

A herb with yellow, saccate flowers. Forms small societies; common. Noglo, June 1961, *Deb* 26337.

I. hypoleuca Hook. f.

A small prostrate herb with pink flowers with recurved spur; common. Khonsa-Laju, June 1961, *Deb* 25950; Tipang, June 1961, *Deb* 25707; Khonsa, June 1961, *Deb* 25920; Jangkeng village, June 1961, *Deb* 25848.

I. latiflora Hook. f. & Thoms.

A much branched succulent herb with red flowers with long curved spur; in moist situation, very common. Chenglang-Khela, Oct. 1959, *Rao* 20286; Jangkeng village, June 1961, *Deb* 25847; Nampong-Pangsupass, Oct. 1959, *Rao* 20076 & 20077.

I. lutea Hook. f. & Thoms.

A herb with yellow flowers with a large conical sac; common. Chennhang, June 1961, *Deb* 26260; Chegum-Wakka, July 1961, *Deb* 26471 & 26472.

I. marianai Roxb.

A herb in flower; scarce. Raho-Wakka, July 1961, *Deb* 26417.

I. porrecta Wall.

A small herb with mauve or violet tinged flowers; common. Noglo, June 1961, *Deb* 26313; Nampong-Pangsupass, Oct. 1959, *Rao* 20078 & 20089.

I. tripetala Roxb. ex DC.

A soft herb with pink flowers; in moist and shaded regions forms societies; common. Jairampur, Oct. 1959, *Rao* 20002; Deomali, Oct. 1959, *Rao* 20389; Kothong, June 1961, *Deb* 26039 & 26096.

I. urticifolia Wall.

A herb with swollen nodes; scarce. Langsang forest, June 1961. *Deb* 26135.

BORAGINACEAE

Cynoglossum wallichii G. Don

An undershrub, hairy all over, with bluish flowers; scarce. Khonsa-Laju, June 1961, *Deb* 25984; Kothong, June 1961, *Deb* 26024 & 26066; Langsang forest, June 1961, *Deb* 26137; Noglo, June 1961, *Deb* 26304.

Tournefortia candollii C. B. Clarke

A rambling shrub with yellow flowers. Raho-Wakka, July 1961, *Deb* 26392.

T. viridiflora Wall.

A scandent shrub with creamy white fruits ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20042 ; Niausa, July 1961, *Deb* 26557.

T. viridilora Wall. var. **griffithii** C. B. Clarke

A scandent shrub in fruit, rare. Lailongsong, 510 m, June 1961, *Deb* 25787.

LABIATAE

Ajuga bracteosa Wall. ex Benth.

A herb with white flowers ; rare. Noglo, June 1961, *Deb* 26356.

Calamintha gracilis Benth.

A herb, common. Jangkeng village, June 1961, *Deb* 26863.

Clinopodium umbrosum (M.-B.) C. Koch

Calamintha umbrosa (M.-Bieb.) Fisch. & May

An aromatic annual herb with pinkish white flowers ; common. Kothong, June 1961, *Deb* 26071 ; Khonsa-Laju, June 1961, *Deb* 25981.

Dysophylla auricularia Bl.

A branching herb with white or pinkish flowers ; scarce. Margharita-Jairampur, Oct. 1959, *Rao* 19932 ; Banfera, July 1961, *Deb* 26698 ; Niausa, July 1961, *Deb* 26565.

Elsholtzia blanda Benth.

A much branched shrub with small, white flowers ; scarce. Noglo-Laju, June 1961, *Deb* 26366 ; Wakka, July 1961, *Deb* 26522 ; Khonsa, June 1961, *Deb* 25923.

Gomphostemma mastersii Benth. ex Hook. f.

A perennial herb with yellow flowers and with nodulose root, common. Deomali, June 1961, *Deb* 25885.

G. parviflorum Wall. ex Benth.

An undershrub with yellow flowers ; scarce. Pungchow, July 1961, *Deb* 26625 ; Margharita-Jairampur, Oct. 1959, *Rao*, 19951 ; Jadua-Banfera, July 1961, *Deb* 26663.

Leucas lavandulaefolia Rees

A small herb with white flowers ; scarce. Chenglang-Margharita & Nampong, March 1958, *Murthy* 12990.

Melissa axillaris (Benth.) Bakh. f.

Melissa parviflora Benth.

A diffused undershrub with white flowers and mostly in marshy places, common. Khonsa-Kheti, Aug. 1958, *Panigrahi* 14528 ; Langsang forest, June 1961, *Deb* 26115 ; Chegum-Wakka, July 1961, *Deb* 26466.

Mosla dianthera (Buch.-Ham.) Maxim.

A small herb with white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19936 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20083 ; Niausa, July 1961, *Deb* 26563.

Nothochaete hamosa Benth.

A herb with pinkish white flowers ; common. Kothong, June 1961, *Deb* 26043 ; Khonsa-Laju, June 1961, *Deb* 25954 & 26003.

Ocimum sanctum Linn.

A small aromatic shrub ; scarce. Chenglang-Margharita-Nampong, March 1958, *Murthy* 12991.

Paraphlomis rugosa Prain

A shrub with white flowers ; common. Chegum-Wakka, July 1961, *Deb* 26464.

Perilla frutescens (Linn.) Britt.

A herb. This species is cultivated along with paddy for seeds from which oil is extracted. Soha village, Oct. 1959, *Rao* 20352.

Plectranthus griffithii Hook. f.

A herb about 1 m in height with pinkish flowers ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20070.

Salvia japonica Thunb.var. **parvifolia** Hamst.

A herb with pinkish red flowers ; scarce. Margharita-Jairampur, Oct. 1959, *Rao* 19909.

Teucrium viscidum Bl.

An annual, in fruit ; common. Jangkeng village, June 1961, *Deb* 25862.

MONOCOTYLEDONS

HYDROCHARITACEAE

Ottelia alismoides (Linn.) Pers.

A hydrophyte with white flowers and ridged fruits; common. Namchick-Chenglang, Oct. 1959, *Rao* 20222 & 20223.

COMMELINACEAE

Aclisia umbellata (Clarke) Brückner

A herb, in fruit. Fruits on maturity turn deep blue; common. Chenglang-Khela, Aug. 1958, *Panigrahi* 14427; Chenglang, Oct. 1959, *Rao* 20253; Deomali, Oct. 1959, *Rao* 20321.

Aneilema scaberrimum (Bl.) Kunth

A slender herb with small bluish flowers; scarce. Jairampur, Oct. 1959, *Rao* 19998.

A. thomsoni C. B. Clarke

A herb with pink flowers; very common. Langsang forest, June 1961, *Deb* 26161.

Commelina paludosa Bl.

A perennial herb with blue or bluish white flowers; common. Jairampur, Oct. 1959, *Rao* 19999; Nampong-Pangsupass, Oct. 1959, *Rao* 20144; Longsek hillock, 1500 m, June 1961, *Deb* 25753.

C. maculata Edgew.

A herb with blue flowers. Chennhang, June 1961, *Deb* 26204.

C. sikkimensis C. B. Clarke

A herb with small, bluish white or deep blue flowers; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20073.

Floscopa scandens Lour.

A trailing herb among herbaceous bushes with bluish white or pinkish flowers; mostly in wet places; common. Margharita-Jairampur, Oct. 1959, *Rao* 19953; Nampong-Pangsupass, Oct. 1959, *Rao*, 20032 & 20143; Chenglang-Khela, Oct. 1959, *Rao* 20272.

Forrestia mollissima (Bl.) Koorder. var. **hispida** (Less. et A. Rich.) Baker

A herb with violet flowers and fruits; common. Chenglang, Oct. 1959, *Rao* 20229; Nampong-Pangsupass, Oct. 1959, *Rao* 20145;

Niausa, July 1961, *Deb* 26558 ; Longsek hillock, 1500 m, June 1961, *Deb* 25754.

Murdannia nudiflora (Linn.) Brenan

A small prostrate herb with small, bluish white flowers and fruits ; common. Chenglang, Oct. 1959, *Rao* 20255 ; Jairampur, Oct. 1959, *Rao* 19980 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20081.

M. lariformis (Hassk.) Rolla Rao et Kammathy

A prostrate herb with violet flowers on humus cover; scarce. Lailongsong, 510 m, June 1961, *Deb* 25836, Jairampur, Oct. 1959, *Rao* 19972.

Pollia hasskerlii Rolla Rao

Pollia aclisia Hassk.

A scandent herb with purplish white flowers and blue-black fruits in the shade of the forest ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20143A.; Kothong, June 1961, *Deb* 26092 ; Longsek hillock, 1500 m, June 1961, *Deb* 25752 ; Pungchow, July 1961, *Deb* 26591.

P. sorzogonensis Endl.

A herb with white flowers ; rare. Banfera-Kanubari, July 1961, *Deb* 26750.

Streptolirion volubile Edgew.

A climber with pinkish, pale creamy or yellowish white flowers subtended by a leafy bract at the base ; scarce. Kothong, June 1961, *Deb* 26086 ; Khonsa-Laju, June 1961, *Deb* 25974.

MUSACEAE

Musa bulbisiana Colla.

A succulent herb with greyish green seeded fruits ; edible. Rusa-Bimalpur, Sept. 1958, *Panigrahi* 17020.

M. rubra Wall. ex Baker

A wild annual herb ; scarce. Lailongsong, 510 m, June 1961, *Deb* 25838 ; *Deb* s.n.

M. sanguinea Hook. f.

An wild banana with small, thin, pale yellowish green fruits, common. Chenglang-Khela, March 1958, *Murthy* 12947, 12948 & 12949.

M. velutina Wendl. & Drude.

An wild plantain with rosy red or pink fruits ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20164 ; Namchick-Chenglang, Oct. 1959, *Rao* 20221 ; Deomali, Oct. 1959, *Rao* 20328 ; Rusa-Bimalpur, Sept. 1958, *Panigrahi* 17055 ; Deomali, June 1961, *Deb* 25902 & 25903.

ZINGIBERACEAE

Alpinia allughas Rosc.

A perennial herb with whitish pink or pinkish red flowers ; common. Forms societies in swampy area. Jadua-Banfera, July 1961, *Deb* 26689.

A. malaccensis (Burm. f.) Rosc.

A stout herb with dull yellowish or very pale brownish flowers and globose fruits ; scarce. Nampong-Pangsupass, March 1958, *Murthy* 13007 ; Raho-Wakka, July 1961, *Deb* 26443.

Amomum aromaticum Roxb.

A rhizomatous herb in fruit. Cultivated. Khela, June 1961, *Deb* 25939.

A. dealbatum Roxb.

A herb with yellowish white flowers ; rare. Banfera, July 1961, *Deb* 26711.

A. linguiferme (Roxb.) Benth.

A rhizomatous herb in fruits only ; scarce. Longsek hillock, 1500 m, June 1961, *Deb* 25758.

Cautleya gracilis (Smith) Dandy

An epiphyte with yellow flowers ; rare. Noglo, June 1961, *Deb* 26358.

Costus speciosus (Koen.) Smith

A herb with white flowered spadix ; rare. Pungchow, July 1961, *Deb* 26577.

C. speciosus (Koen.) Smith var. **argyrophylus** Wall. ex Baker

A perennial herb with white flowered spadix ; scarce. Namchick, Oct. 1959, *Rao* 20182 ; Pungchow, July 1961, *Deb* 26577.

Globba multiflora Wall. ex Baker

A perennial herb with orange yellow flower and fruits; scarce. Chenglang, Aug. 1958, *Panigrahi* 14473 ; Jangkeng village, June 1961, *Deb* 25872.

G. orixensis Roxb.

A perennial herb with yellowish or orange red flower; scarce. Raho-Wakka, July 1961, *Deb* 26444.

Hedychium cernuum Wight

A herb in fruit and with perennial rhizome; scarce. *Deb* s.n.

H. coccinium Buch.-Ham. ex Smith

A herb. Deomali, June 1961, *Deb* 25904.

H. coccinium Buch.-Ham. ex Smith var. **angustifolium** Roxb.

A herb with blood red flowers; rare. Wakka, Sept. 1958, *Panigrahi* 16902.

H. coccinium Buch.-Ham. ex Smith var. **longifolium** (Rosc.) Baker

A tall herb with red flowers; scarce. Jadua, July 1961, *Deb* 26655.

H. coronarium Koening

A herb in swamp and marshy area. Flowers white; perianth sweet scented; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20288; Deomali, Oct. 1959, *Rao* 20390.

H. marginatum Clarke

A herb with sweet scented flowers; rare. Jadua-Banfera, July 1961, *Deb* 26688.

H. stenopetalum Lodd.

A perennial herb with sweet scented white flowers; scarce. Laju hills, Aug. 1958, *Panigrahi* 14691; Lailongsong, 510 m, June 1961, *Deb* 25832; Wakka-Nagminu, July 1961, *Deb* 26548.

H. villosum Wall.

A herb with light brown flowers. Mostly on moist slopes and rocky crevices; scarce. Chenglang-Khela, March 1958, *Murthy* 12939; Wakka-Nagminu, July 1961, *Deb* 26547.

Hitchenia careyana (Wall.) Benth.

A tall herb with slightly pinkish white flowers; scarce. Jairampur, Oct. 1959, *Rao* 20004.

CANNACEAE

Canna flaccida Salisb.

An ornamental plant with rosy red flowers; cultivated. Chenglang-Khela, Oct. 1959, *Rao* 20284.

MARANTACEAE

Phrynium placentarium (Lour.) Merr.

A perennial herb in inflorescence; forming large societies; common. Lailongsong, 510 m, June 1961, *Deb* 25837; Longsek hillock, 1500 m, June 1961, *Deb* 25759.

LILIACEA

Asparagus filicinus Buch.-Ham. ex D. Don

A climber in open areas of the forest; scarce. Chennhang, June 1961, *Deb* 26283 & 26288.

Dianella ensifolia Redoute

A perennial herb with small, bluish-white flowers and pale green fruits; rare; mostly on moist slopes. Nampong-Pangsupass, Oct. 1959, *Rao* 20110.

Disporum cantoniense (Lour.) Merr.

Disporum pullum Salisb.

A herb in flowers and fruits; fairly abundant. Langsang forest, June 1961, *Deb* 26159; Raho-Wakka, July 1961, *Deb* 26456.

Ophiopogon intermedius D. Don

A herb with white flowers: common. Chennhang, June 1961, *Deb* 26284.

O. wallichianus (Kunth) Hook. f.

A perennial herb with white flowers; forms societies; very common. Chennhang, June 1961, *Deb* 26285, 26286 & 26287.

Polygonatum brevistylum Baker

An epiphyte in flowers and fruits. Noglo, June 1961, *Deb* 26357.

This is of restricted distribution in Sikkim, Abor Hills, Nagaland and Tirap.

Polygonatum oppositifolium (Wall.) Royle

An epiphyte in flowers and fruits. Pungchow, July 1961, *Deb* 26633.

Smilacina fusca Wall.

A herb in fruits; forms an undergrowth; common. Chennhang, June 1961, *Deb* 26289.

TRILLIACEAE

Paris polyphylla Smith

A small herb in flowers and fruits ; as an undergrowth in the evergreen forest ; scarce. Langsang forest, June 1961, *Deb* 26162 ; Wakka, July 1961, *Deb* 26526 ; Chegum-Wakka, July 1961, *Deb* 26462.

SMILACACEAE

Smilax lanceifolia Roxb.

A climber ; in flower ; scarce. Chegum-Wakka, July 1961, *Deb* 26489.

S. perfoliata Lour.

A climber ; in flower and fruit. Jairampur, Oct. 1959, *Rao* 19988.

S. zeylanica L.

A climber. Kothong, June 1961, *Deb* 26087

S. orthoptera A. DC.

S. roxburghiana Wall. ex Hook. f.

A spiny climber ; in fruit ; scarce. Chenglang, March 1958, *Murthy* 12909 ; Chennhang, June 1961, *Deb* 26228 ; Langsang forest, June 1961, *Deb* 26156.

ARACEAE

Alocasia fornicata (Roxb.) Schott.

A herb. Wakka-Nagminu, July 1961, *Deb* 26546.

A. indica (Roxb.) Schott.

A tall herb in fleshy, golden yellow spathe ; scarce. Banfera-Kanubari, July 1961, *Deb* 26751 ; Chennhang, June 1961, *Deb* 26229.

Amorphophallus bulbifera (Roxb.)Bl.

A herb in red fruits. Khonsa-Laju, June 1961, *Deb* 26011.

Arisaema consanguineum Schott.

A succulent herb with palmate and digitate leaves ; scarce. Langsang forest, June 1961, *Deb* 26160 ; Chegum-Wakka, July 1961, *Deb* 26496.

Colocasia affinis Schott.

It is an extensively cultivated herb. Soha village, Oct. 1959, *Rao* 20357 ; Jangkeng village, June 1961, *Deb* 25874 ; Longsek hillock, June 1961, *Deb* 25760.

C. esculenta (L.) Schott.

A herb with large yellowish spathe; scarce. Tipang, June 1961, *Deb* 25712.

Homalomena aromatica Schott.

A herb with perennial root stock; forms the ground cover; scarce. Banfera-Kanubari, July 1961, *Deb* 26752.

Pothos cathcarti Schott.

A branched climber; in fruit; common. Crushed leaves without juice is commonly used as a bandage for sprain and bone fractures by the Thangsias as a medicinal plant. Chenglang-Khela, March 1958, *Murthy* 12936; Kothong, June 1961, *Deb* 26093; Khonsa-Laju, June, 1961, *Deb* 26009.

P. scandens Linn.

An epiphytic herb; in fruit; common. Chenglang-Khela, March, 1958, *Murthy* 12936A; Chennhang, June 1961, *Deb* 26290; Way to Niausa, July, 1961, *Deb* 26560.

Rhaphidophora decursiva (Roxb.) Schott.

A large epiphytic climber; in fruit; common. Kothong, June 1961, *Deb* 26088; Raho-Wakka, July 1961, *Deb* 26445.

R. glauca (Wall.) Schott.

A small herb on dry mossy rocks. Pangsupass, March 1958, *Murthy* 13011.

R. hookeri Schott.

An epiphyte, very common. Pungchow-Niausa, July 1961, *Deb* 26652; Chennhang, June 1961, *Deb* 26282.

AMARYLLIDACEAE

Crinum pratense Herb.

A herb with white flowers and underground bulb. Cultivated mostly in plains. Soha village, Oct. 1959, *Rao* 20371; Pungchow, July 1961, *Deb* 26581.

ROXBURGHIACEAE

Stemone tuberosa Lour.

A twiner: in fruit; scarce. Lailongsong, 510 m, June 1961, *Deb* 25839.

DIOSCOREACEAE

Dioscorea anguina Roxb.

A twiner with creamy white flowers ; common. Deomali, Oct. 1959, *Rao* 20319 ; Nampong-Soha, Oct. 1959, *Rao* 20348.

D. bulbifera Linn.

A large twiner with small white flowers ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20302 ; Jairampur, Oct. 1959, *Rao* 19974 ; Kothong, June 1961, *Deb* 26091 ; Chennhang, June 1961, *Deb* 26199 ; Pungchow-Niausa, July 1961, *Deb* 26650.

D. glabra Roxb.

A climber in flowers ; bulbils dark brown ; scarce. Margharita-Jairampur, Oct. 1959, *Rao* 19927 ; Chenglang, Oct. 1959, *Rao* 20251.

D. hamiltoni Hook. f.

A twiner with small yellow flowers ; rare. Jairampur, Oct. 1959, *Rao* 19983.

D. laurifolia Wall. ex. Hook. f.

A climber with small flowers, rare. Pungchow, July 1961, *Deb* 26589. This is a Malaysian plant recorded for India by Deb & Kataki in *Bull. Bot. Surv. India* 5(2) : 163, 1963.

D. oppositifolia Linn.

A climber ; in fruit ; scarce. Jangkeng village, June 1961, *Deb* 25873.

D. pentaphylla Linn.

A climber ; in flowers and fruits ; scarce. Laju-Raho, Aug. 1958, *Panigrahi* 14721, Chenglang-Khela, Oct. 1959, *Rao* 20301 ; Soha village, Oct. 1959, *Rao* 20362.

AGAVACEAE

Pleomele angustifolia (Roxb.) N.E. Brown

Dracaena angustifolia Roxb.

A shrub ; scarce. Pungchow, July 1961, *Deb* 26632.

P. petiolata (Hook. f.) N.E. Brown

Dracaena petiolata Hk. f.

A tall herb with dark green fruits ; rare. Deomali, Oct. 1959, *Rao* 20330.

PALMAE

Arenga saccharifera Labill.

A tree ; scarce. Chenglang, June 1961, *Deb* 26197.

Calamus erectus Roxb. var. **macrocarpa** (Griff.) Becc.

An erect palm with big bunches of brown fruits. Chenglang, Oct. 1959, *Rao* 20227.

C. flagellum Griff.

A straggler with prickly fruits ; prickles strong ; fruits edible ; common. Banfera-Kanubari, July 1961, *Deb* 26749 ; Margharita-Jairampur, Oct. 1959, *Rao* 19957.

C. floribundus Griff.

A climber ; common. Longsek hillock, 1500 m, June 1961, *Deb* 25756.

C. gracilis Roxb.

Cane ; prickles curved downwards ; inflorescence long pendent. Banfera, July 1961, *Deb* 26714.

C. leptospadix Griff.

A climber ; in fruit, growing together on slopes. Common in humid valleys. Jadua, July 1961, *Deb* 26654.

Didymosperma nana H. Wendle & Drude

A tree ; rare. Niausa-Wanu, Sept. 1958, *Panigrahi* 15078.

Licuala spinosa Wurmb.

A tree with bluish green fruits and circular leaves, fairly common. Niausa-Wanu, Sept. 1958, *Panigrahi* 15076.

Pinanga gracilis Bl.

A common perennial shrub with female flowers in spike from the lower nodes ; fruits oval, green, smooth ; Namsang-Soha, Oct. 1959, *Rao* 20351A ; Banfera, July 1961, *Deb* 26715 & 26716.

Wallichia caryotoides Roxb.

A tree ; in fruit ; common. Chenglang, Oct. 1959, *Rao* 20228 ; Kothong, June 1961, *Deb* 26099 ; Chennhang, June 1961, *Deb* 26197.

W. densiflora Mart.

An evergreen shrub with red ripe fruits ; common. Namchick-Chenglang, Oct. 1959 ; *Rao* 20220 ; Banfera, July 1961, *Deb* 26717 ; Longsek hillock (Chenglang), 1500 m, June 1961, *Deb* 25757.

HYPOXIDACEAE

Hypoxis aurea Lour.

A herb with yellow flowers. Chennhang, June, 1961, *Deb* 26200; Noglo-Laju, June 1961, *Deb* 26367.

TACCACEAE

Tacca integrifolia Ker-Gawl.

A perennial herb with pink to chocolate brown flowers; rare. Jadua-Banfera, July 1961, *Deb* 26666.

T. laevis Roxb.

A perennial herb with winged fruits; fairly common. Niausa-Wanu, Sept. 1958, *Panigrahi* 15068.

ORCHIDACEAE

Acampe longifolia (Lindl.) Lindl.

Saccolabium longifolium (Lindl.) Hook. f.

A large epiphyte in young fruits and greenish pink flower buds; scarce. Namchick-Changlang, Oct. 1959, *Rao* 20219.

Agrostophyllum khasianum Griff.

An epiphytic on trees; pseudo-bulb 15 cm long, flower white, sessile. Deomali, Oct. 1959, *Rao* 20329; Banfera, July 1961, *Deb* 26718.

Arachnis flos-aeris (L.) Reichb. f.

An epiphyte; in fruit; rare. Namchick, Oct. 1959, *Rao* 20208.

Arundina graminifolia (D. Don) Hochreutiner

Terrestrial among the grasses on the hill slopes with bright mauve or lilac red flowers, labellum white with reddish tinge. Nampong-Pangsupass, Oct. 1959, *Rao* 20074, 20075; Margharita-Jairampur, Oct. 1959, *Rao* 19958.

Bulbophyllum confertum Hook. f.

A lithophyte. Grows in clusters on rocks with small pseudo-bulb and a single leaf; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20137.

B. reptans Lindl.

An epiphyte; pseudo-bulb one flowered; scarce. Chennhang, June 1961, *Deb* 26301.

B. triste Reichb. f.

An epiphyte in light yellow flowers; fairly common. Pūngchow, July 1961, *Deb* 26635.

Bulleyia yunnanensis Schltr.

Grows on trunks of trees and in humus covered boulders in mixed forest at 1000-2700 m in altitude; flowering in June-August. A native of China recorded from India by *Deb* in *Ind. For.* **91**(3): 193, 1965. Chennhang, June 1961, *Deb* 26291.

Calanthe densiflora Lindl.

Terrestrial among grasses on hill slopes; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20111.

Coelogyne fuscescens Lindl.

Terrestrial in humid environment; in fruit; fairly common. Nampong-Pangsupass, Oct. 1959, *Rao* 20118.

C. ovalis Lindl.

A lithophyte with creamy-white flowers; Labellum with chocolate brown ridges on the upper surface; the rim is covered with hairy outgrowth; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20123; Soha village, Oct. 1959, *Rao* 20381.

C. prolifera Lindl.

An epiphyte; pseudo-bulb two-leaved. Longsek hillock, 1500 m, June 1961, *Deb* 25766.

Cryptochilus lutea Lindl.

An epiphyte; in fruit; scarce. Raho-Vokanoska, Aug. 1958, *Panigrahi* 16866.

C. sanguinea Wall.

An epiphyte with yellow flowers; common. Chennhang, June 1961, *Deb* 26295.

Cymbidium simulans Rolfe

An epiphyte with pinkish-yellow flowers; fairly common. Jadua-Banfera, July 1961, *Deb* 26690.

C. devonianum Paxt.

An epiphyte; in fruit; fairly common. Nampong-Pangsupass, Oct. 1959, *Rao* 20115.

Dendrobium acinaciforme Roxb.

An epiphyte with white flowers with brownish patch in the labellum; and long stalked fruits ; rare. Niausa-Wanu, Sept. 1958, *Panigrahi* 15100 ; Banfera, July 1961, *Deb* 26719.

D. calceolaria Carey

An epiphyte; in fruit; common. Banfera-Kanubari, July 1961, *Deb* 26753.

D. candidum Wall.

An epiphyte. Banfera, July 1961, *Deb* 26720.

D. chrysanthum Wall. ex Lindl.

An epiphyte; in fruits ; rare. Khonsa, June 1961, *Deb* 25914.

D. lituiflorum Lindl.

An epiphyte ; common. Chenglang, Oct. 1959, *Rao* 20242 ; Soha village, Oct. 1959, *Rao* 20370A.

D. nobile Lindl.

A lithophyte ; not rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20114.

Ephemerantha macraei (Lindl.) P. F. Hunt & Summerhayes

Dendrobium macraei Lindl.

An epiphyte ; common. Nginu, Aug. 1958, *Panigrahi* 14840; Margharita-Jairampur, Oct. 1959, *Rao* 19963 ; Wakka-Nagminu, July 1961, *Deb* 26550.

Eria acervata Lindl.

A small epiphyte; in flower ; common. Wakka-Nginu, July 1961, *Deb* 26551.

E. flava Lindl.

A lithophyte with brown fruits ; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20116.

E. paniculata Lindl. ex Wall.

An epiphyte on *Saurauja* sp. with small whitish flowers ; rare. Khonsa-Laju, June 1961, *Deb* 26013 ; Deomali, June 1961, *Deb* 25907.

E. rufinula Reichb. f.

An epiphyte or a lithophyte with small white and axillary flowers ; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20131 ; Deomali, Oct. 1959, *Rao* 20326.

Galeola falconeri Hook. f.

A very delicate terrestrial orchid with small white flower buds; not scarce. Nampong-Pangsupass, March 1958, *Murthy* 13009.

Gastrochilus calceolaris (Smith) D. Don

An epiphyte; scarce. Chennhang, June 1961, *Deb* 26231; Langsang forest, June 1961, *Deb* 26164.

Liparis assamica K. & P.

An epiphyte in small yellow flowers; scarce. Chenglang, Oct. 1959, *Rao* 20236; Kothong, June 1961, *Deb* 26100.

L. caespitosa (Thouars) Lindl.

An epiphyte in small, greenish yellow flowers and green fruits; common. Chennhang, June 1961, *Deb* 26293.

Malaxis wallichii (Lindl.) Deb

A terrestrial orchid in flower. Longsek hillock, 1500 m, June 1961, *Deb* 25765.

Oberonia emarginata King & Prantl.

An epiphytic orchid in flower. Longsek hillock, 1500 m, June 1961, *Deb* 25767.

O. iridifolia (Roxb.) Lindl.

An epiphyte with inconspicuous flowers; scarce. Kothong, June 1961, *Deb* 26097.

O. myriantha Lindl.

An epiphytic orchid; scarce. Soha village, 1067 m, Oct. 1959, *Rao* 20379.

Ophrys muscifera Huds.

An epiphyte on mossy bark of trees with greenish-yellow flowers; rare. Nagnu, August 1958, *Panigrahi* 14851.

Otochilus porrecta Lindl.

An epiphyte with a very long pendulous inflorescence; fruits pinkish; fairly common. Soha village, 1067 m, Oct. 1959, *Rao* 20373.

Phajus longipes (Hook. f.) Holtt.

A ground orchid on very damp and moist slopes with lemon-yellow flowers. Nampong-Pangsupass, March 1958, *Murthy* 13005.

Pholidota articulata Lindl.

An orchid on dry soil or hard rocky slopes or epiphytic; in fruit; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20092; Nampong-Pangsupass, March 1958, *Murthy* 13010; Khonsa-Laju, June 1961, *Deb* 26012.

P. imbricata (Roxb.) Lindl.

An epiphyte with pink flowers and brown bracts; not scarce. Soha village, Oct. 1959, *Rao* 20374; Margharita-Jairampur, Oct. 1959, *Rao* 19960.

Pleione praecox (Smith) D. Don

An epiphyte; scarce. Deomali, June 1961, *Deb* 25910.

Podochilus cultratus Lindl.

An epiphyte; rare. Deomali, June 1961, *Deb* 25906.

Polystachya wightii Reichb. f.

An epiphyte; scarce. Jadua-Banfera, July 1961, *Deb* 26692.

This has been reported from Malabar only. This record from NEFA is interesting.

Sarcanthus filiformis Lindl.

An epiphyte with whitish purple flowers; not rare. Pungchow-Niausa, July 1961, *Deb* 26653.

S. subulatus (Bl.) Reichb. f.

An epiphyte with white flowers and fruits; not scarce. Jadua-Banfera, July 1961, *Deb* 26691; Deomali, Oct. 1959, *Rao* 20327; Chennhang, June 1961, *Deb* 26292.

Schoenorchis gemmata (Lindl.) J. J. Smith

An epiphyte with violet flowers and white labellum; rare. Khonsa-Laju, June 1961, *Deb* 26014.

Stauropsis undulatus Benth.

An epiphyte; not rare. Chenglang, Oct. 1959, *Rao* 20244.

Thunia marshalliana Reichb. f.

An epiphyte; in fruit; perianth persistent; common. Nagnu-Niausa, Aug. 1958, *Panigrahi* 14844.

Uncifera acuminata Lindl.

Saccolabium acuminatum (Lindl.) Hook. f.

An epiphyte; not rare. Langsang forest, June 1961, *Deb* 26165.

U. obtusifolia Lindl.

An epiphytic orchid ; not rare. Chenglang, Oct. 1959, *Rao* 20245.

Vanda caerulea Griff. ex Lindl. (Eng : *Blue Vanda*)

An epiphyte with showy light blue flowers and long, ribbed fruits ; not rare. Chenglang, Oct. 1959, *Rao* 20241.

CYPERACEAE

Carex indica Linn.

A perennial herb ; rare. Chenglang, Aug. 1958, *Panigrahi* 14458.

C. insignis Boott.

A herb; common along foot paths. Langsang forest, June 1961, *Deb* 26163.

C. remota Linn.

A herb ; very common. Chegum-Wakka, July 1961, *Deb* 26498.

C. spiculata Boott. *var.* **nobilis** (Boott.) Hook. f.

A perennial herb with greenish-brown fruits. Laju-Raho, Aug. 1958, *Panigrahi* 14742.

C. cyperoides (Linn.) O. Kuntze var. **evolutor** C. B. Clarke

An annual in moist situation ; not rare. Noglo, June 1961, *Deb* 26302.

Cyperus diffusus Vahl

A herb with umbellate heads ; common. Longsek hillock, June 1961, *Deb* 25761.

C. iria Linn.

A perennial herb in swampy area ; common. Khonsa, June 1961, *Deb* 25924.

C. uncinatus Poir.

An annual herb in brown alluvial soil ; common. Longhoi-Rusa, Sept. 1958, *Panigrahi* 16765.

Fimbristylis diphylla (Retz.) Vahl

A herb ; common. Khonsa, June 1961, *Deb* 25925 ; Longsek hillock, 1500 m, June 1961, *Deb* 25764.

Mariscus cyperinus Vahl *var.* **bengalensis** C. B. Clarke

A perennial herb; not rare. Kheti-Tinchha, Aug. 1968, *Panigrahi* 14576.

Scleria cochinchinensis (Lour) Druce

A tall herb in wet places; common. Jairampur, Oct. 1959, *Rao* 19991.

GRAMINEAE

Agrostis myriantha Hook. f.

A herb; common. Kothong, June 1961, *Deb* 26102; Langsang forest, June 1961, *Deb* 26157.

Arthrazon nudus (Steud.) Hochst.

A scandent herb in forest clearances; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20086.

Bambusa nutans Wall. ex Munro

A tall climbing bamboo; not rare. Chennhang, June 1961, *Deb* 26226.

B. pallida Munro

A tall bamboo about 20-30 m in height, bracts small; not rare. Soha village, Oct. 1959, *Rao* 20364.

Capillipedium assimile (Steud.) A. Camus

An annual semiprostrate herb; spikelets greyish green, crowded awned; common. Wakka, July 1961, *Deb* 26525.

Centotheca lappacea (Linn.) Desv.

A grass of the way side with broad leaf; very common. Nampong-Pangsupass, Oct. 1959, *Rao* 20052.

Coix lacryma-jobi Linn.

A perennial grass in swampy places and on hill slopes; not scarce. Niausa, July 1961, *Deb* 26559.

C. lacryma-jobi Linn. *var.* **mayuen** (Romanet) Stapf

A cultivated grass. This is chiefly used for the packing of beverage. Soha village, Oct. 1959, *Rao* 20366.

Dendrocalamus hamiltonii Nees et Arn. ex Munro

A tall bamboo; in flower. It is one of the commonest bamboo in Assam; very common. Pungchow, July 1961, *Deb* 26634; Tipang, 540 m, June 1961, *Deb* 25714; Banfera-Kanubari, July 1961, *Deb* 26755.

D. hookeri Munro

A bamboo; bracts pinkish-brown. Shoot is not edible. Fruits are in cluster at the nodes, ash grey in colour, not rare. Kothong, June 1961, *Deb* 26089; Namsang-Soha, Oct. 1959, *Rao* 20349; Soha village, Oct. 1959, *Rao* 20365.

Digitaria ternata (A. Rich.) Stapf ex Dyer

It is one of the commonest way side grasses; very common. Nampong-Pangsupass, Oct. 1959, *Rao* 20085.

Echinochloa colonum (Linn.) Link.

A common grass. Namchick, Oct. 1959, *Rao* 20171.

Eleusine indica (L.) Gaertn.

A small grass in marshy places; not rare. Namchick, Oct. 1959, *Rao* 20172

Eragrostis unioloides (Retz.) Nees ex Steud.

A prostrate grass all along the way side with a panicle of spikelets; common. Margharita-Jairampur, Oct. 1959, *Rao* 19923; Nampong-Pangsupass, Oct. 1959, *Rao* 20068; Namchick, Oct. 1959, *Rao* 20186.

Hordeum vulgare Linn.

Cultivated along the moist soil slopes and rocky edges; common. Khela, March 1958, *Murthy* 12882.

Imperata cylindrica (Linn.) P. Beauv. *var.* **major** (Nees) C. E. Hubb.

A perennial herb; common. Kothong, June 1961, *Deb* 26023.

Microstegium vagans (Nees ex Steud.) A. Camus

A perennial herb, hairy; common. Niausa-Wanu, Sept. 1958, *Panigrahi* 15006.

Neyraudia reynaudiana (Kunth) King ex Hitch.

A tall grass about 2-3 m in height; among bushes; very common. Nampong-Pangsupass, Oct. 1959, *Rao* 20162; Namsang-Soha, Oct. 1959, *Rao* 20343.

Oplismenus compositus (Linn.) P. Beauv.

A very common herb. Longsek hillock, 1500 m, June 1961, *Deb* 25762.

Oryza sativa L.

Cultivated paddy, awnless on dry hill slopes. Soha village, Oct. 1959, *Rao* 20367.

Panicum auritum Presl. ex Nees

A perennial tall grass; not rare. Namchick, Oct. 1959, *Rao* 20187.

Panicum khasianum Munro ex Hook. f.

A herb. Aug. 1958, *Panigrahi* s.n.

P. miliaceum Linn.

An annual herb, cultivated, grain awnless. Khonsa-Laju, June 1961, *Deb* 26008.

P. montanum Retz.

A herb; not common. Banfera-Kanubari, July 1961, *Deb* 26754.

Paspalum conjugatum Berg.

A perennial creeper amidst rocks; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20046.

P. scrobiculatum Linn.

A herb. Sometimes cultivated; common. Longsek Hillock, 1500 m, June 1961, *Deb* 25763.

Phragmites karka (Retz.) Trin. ex Steud.

A tall perennial grass. A dominant species from Niausa. Lailongsong, 510 m, June 1961, *Deb* 25835; Jairampur, Oct. 1959, *Rao* 19996.

Pogonatherum crinitum (Thunb.) Kunth

A herb on rocks of slopes. Common. Kothong, June 1961, *Deb* 26101; Khonsa-Laju, June 1961, *Deb* 26010.

Pseudoechinolaena polystachya (H.B.K.) Stapf

A herb, very common. Pungchow, July 1961, *Deb* 26636.

Pseudostachyum polymorphum Munro

A bamboo about 5-10 m in height; common. Chenglang-Khela, Oct. 1959, *Rao* 20299.

Saccharum arundinaceum Retz.

Common plant in clearances. Nampong-Pangsupass. Oct. 1959, *Rao* 20159.

Sacciolepis indica (Linn.) A. Chase

A herb; common. Lailongsong, 510 m, June 1961, *Deb* 25833.

Setaria glauca (Linn.) P. Beauv.

An annual grass; common. Kheti-Tinchha, Aug. 1958, *Panigrahi* 14577; Laju-Raho, Aug. 1958, *Panigrahi* 14750.

S. italica (Linn.) P. Beauv.

A herb ; cultivated widely for grains used in preparing beverages ; Khonsa, June 1961, *Deb* 26007.

S. pallide-fusca (Schum.) Stapf et C. E. Hubb.

An annual grass ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20088.

S. palmifolia (Koen.) Stapf

A tall perennial grass ; common. Jairampur, Oct. 1959, *Rao* 19992 ; Rusa, Sept. 1958, *Panigrahi* 16996.

Sporobolus fertilis (Steud.) W. D. Clayton

A grass. *Panigrahi* s.n.

Themeda villosa (Poir.) A. Camus

A tall grass forming mostly impenetrable thickets ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19930.

Thysanolaena maxima (Roxb.) O. Kuntze

One of the very common long grasses in this area. Nampong, Oct. 1959, *Rao* 20163 ; Lailongsong, 510 m, June 1961, *Deb* 25834.

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Miscellaneous Notes

1. FURTHER ATTEMPTS TO DETERMINE THE FOOD HABITS OF THE INDIAN RHINOCEROS AT KAZIRANGA

In an earlier communication (Brahmachary *et al.* 1971) the attempt to determine the food habits of the Rhino in Jaldapara, was described. It was concluded that observing the microscopic sections of the vegetal remains in the dung was a good technique, especially for Jaldapara or other similar places where direct observation is difficult due to the nature of the terrain and vegetation.

The present report describes results of a study in Kaziranga during about a fortnight in January, 1972. Unlike at Jaldapara, direct observation at Kaziranga turned out to be very simple because one can approach the rhinos to very close quarters while mounted on elephants and the grass being short in certain seasons, the actual grass species fed on by the rhinos can be noted. Over the years the mahouts have also noticed these grasses and plants so that the food habits are largely known. The following are our findings.

Plants germinated in the dung:

This, according to us, is the most important result of the present study. *Old* dung balls, examined on breaking open, revealed plants germinated inside them. We did not examine the old dung balls in Jaldapara and therefore missed this aspect. At Arimora (Kaziranga) startlingly large numbers of grass stems, producing roots and stems with leaflets at nodes, were found inside the dung balls. We also detected two dicot seedlings. As we were not equipped for carrying these back to Calcutta and cultivating them, we tried to bring only a few packed in a very small tin container and practically none survived the ordeal.

Only one grass stem with leaves, on being transplanted to a pot in Calcutta, grew up to a certain small but detectable size. Although precise identification is not possible under these circumstances, this grass seemed to be almost certainly *Cynodon dactylon*, one of the common lawn grasses. Practically all other grass stems germinated inside the dung balls at Arimora were of a different type. They were certainly of the creeping type and from the description 'rooting at nodes' by Mahanta and Neog (1968) seem to be 'Alaijabari' (*Drymaria cordata*).

The interesting point about this preliminary observation is that this can be developed into a technique for determining the food habits in terrain where direct observation is difficult or impossible for, the plants can be cultivated, locally, in pots or in plots of garden; secondly, the implication points out a new means of dispersal for grass and is therefore of ecological importance. Bor (1960) describes the different mechanisms for dispersal of grass through animal agents but dispersal through alimentation has not been considered probably because the herbivores in general (like cattle or deer) digest the grass thoroughly. The rhino and the elephant pass on large undigested pieces through their alimentary canal and into the dung. We did not find germinating grasses inside the old elephant dung but the large quantities observed in rhino dung effectively prove that this animal plays a role in the dispersal of grass.

Solanum khasianum (Ban-Begun) is often found to grow around rhino dung, as has also been noticed by the local people. We noticed 20 cases of such luxuriant growth of this plant around rhino dung. Not a single case of such growth was found in the few plants we noticed in places where no dung had been excreted. We also assured that the young plant were growing from *inside* the dung ball, and not from the soil below. Birds can also drop the seeds, accidentally, on the fresh dung but this is unlikely in so many instances. The Rhino, therefore, seems to act as an agent for dispersal and concentration of this plant. Apparently, the dung also acts as a source of manure and/or moisture, which in turn may affect the chemical contents of the plant like solasodine (see later).

Direct observation :

We observed Rhinos feeding voraciously on *Flemingia lineata,* a small shrub. Even plants partially burnt black and apparently totally dry were plentifully eaten. This is the only non-grass species we could directly observe during the actual process of eating. The prehensile upper lip is very handy in manipulating such shrubs and clumps of tall grasses.

The rhinos fed on almost all the grassy growths, the very short grasses creeping on the soil as well as tall grasses from part of their menu. All these grasses can easily be identified if the inflorescence is available.

We could collect inflorescence of the following 11 species while

Mahanta and Neog (loc. cit.) list 26 species of common grasses. Attempts at other seasons, in particular early monsoon, would no doubt be very fruitful for collecting the remainig species:

		local name
1.	*Imperata cylindrica*	ulu
2.	*Eragrostis gangetica*	
3.	*Cyperus rotundus*	
4.	*Vetiveria zizanioides* (see below)	
5.	*Aristida cyanantha*	
6.	*Sporobolus diandra*	
7.	*Chrysopogon aciculatus*	bonguti
8.	*Thysanolaema phragmites*	
9.	*Rhynchospora aurea*	
10.	Unidentified	
11.	*Arundo donax*	Nal

[one of these, locally known as Birina, was identified by the Botanical Survey of India, Culcutta, as *Vetiveria zizaniodies* although according to Mahanta and Neog (loc. cit.) it is *Erianthus elephantius*].

Examination of vegetal remains in the dung:

It is well known at Kaziranga that the rhinos now plentifully eat water-hyacinth. We also detected numerous remains of water-hyacinth strips in various dung balls near the marshy places.

More than 1500 undigested stems were collected from various dung balls but it became soon apparent that the technique of examining the microscopic sections of these remains would be unnecessary in case of the openland rhino at Kaziranga. Unfortunately very few stems in good condition were found in the dung balls collected from the woodland. Of the 12 stems which allowed sectioning only 3 were dicot species.

Chemical studies. (*a*) It is of great interest to study the nutritional and other chemical aspects of the local plants consumed by the wild animals. Apart from the question of wild game management, such studies might lead to the discovery of superior food for domestic livestock and of useful drugs.

Mahanta and Neog (loc. cit.) sum up the data on total nitrogen content, mineral content etc. in some of the commoner grasses of Assam. An important new aspect of study will be the estimation of certain amino-acids like lysine, cystein, methionine etc. Lysine-rich corn or wheat has appeared as a great boon. Harpstead (1971) reviews the experiments on lysine-rich corn and shows how it may spell the difference between life and death. Leaf protein is however rich in lysine (Pirie 1969) (unlike seeds, grains etc.). Again, in certain grasses, TCA-soluble and TCA-insoluble nitrogen are about equal in amount (Pirie 1971) so that free amino-acids are present in large quantities and are therefore worth estimating.

(*b*) These studies can be carried out only in a local laboratory but we have made some preliminary tests with the leaves of solanum and lawn grass (*Cynodon dactylon*) obtained from the outskirts of Calcutta (which may thus differ from the Kaziranga samples).

One dimensional paper chromatography showed only one or two large free pools of amino-acids in solanum leaves while 5 such pools were traceable in *Cynodon*. With 2-dimensional chromatography, the latter would probably resolve a larger number of amino-acids. None of these amino-acids seemed to coincide with 'marker' lysine.

(*c*) *Remarks:*

Laijabari grass (*Drymaria cordata*) is the richest in calcium of all the Assam grasses which are generally calcium poor (Mahanta & Neog 1968). It is good that rhinos eat this species plentifully.

Water-hyacinth is not a very good food for its dry weight is only about 9-10% and of that about 10% is protein (Matai, pers. comm.). Good grass is preferable to this pestiferous weed.

Cynodon dactylon (dub or lawn grass) can produce HCN (Bor, loc. cit.) under certain conditions of drying so that in certain years, such as of extreme drought, places with extensive growth of this grass should perhaps be burnt off.

Solanum khasianum has gained some reputation as the source of an alkaloid (solasodine) which may act as a precursor of steroid hormones and as such may be of interest as a commercial source for drug manufacturers (Maiti *et al.* 1964; Maiti & Mathew 1967; Saini 1966). As manuring has an influence on the alkaloid content (Biswas, pers. comm.), the vigorously growing plants around the rhino dung are worth studying.

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2. ON THE INCREASING OCCURRENCE OF TYPICALLY PLAINS-BIRDS IN THE KUMAON HILLS

For many years now, I have been bird-watching in the Lake region of Kumaon, comprising the five lakes of Sattal, Naukuchiatal, Bhimtal, Khurpatal and Nainital as well as the surrounding hills. The area under observation extends from 1286 m (4220′) which is the level of the Sattal lakes, to 2591 m (8500′), the height of Cheena Peak above Nainital, and has direct access to the plains by means of several steep river valleys.

In the fifties and early sixties I had made a detailed list of the birds occurring in the area with some notes on distribution, status and habitat, but since 1964 I have been abroad, returning to India about once every two years for a month or two, generally in winter and early spring. During each visit, I have made new entries in my list, of birds not observed before in the area. Surprisingly almost all of the ‘ new ’ birds are typical low-elevation species, no new records of high-elevation species having been made during the same interval. A list of these birds that have now become resident in the area is given below:

1. **Purple Sunbird** *Nectarinia asiatica.* Although this bird is known to ascend to 5000′ in the Himalayas (Whistler 1941) it is mentioned here as its status has changed from that of a scarce summer visitor to a common resident at Bhimtal, 4340′ (1320 m).

2. **Crowpheasant** *Centropus sinensis.* This bird is also known to occur up to 6000′ (1830 m), but whereas it had never been observed in the Lake Region before, a pair have now taken up residence at the headquarters of the Bhimtal lake.

3. **Blackwinged Kite** *Elanus caeruleus.* This is also a low-elevation bird that was only rarely seen before, but now regularly breeds at Bhimtal. It is however, not resident, being only rarely seen in winter.

4. **Grey Partridge** *Francolinus pondicerianus*. A party of these birds has been resident at Mehragaon above Bhimtal for many years, and are not newcomers like the others. However, this is probably a new altitudinal record, as both Whistler (1941) and Sálim Ali (1946) give 1500′ as the height to which this bird ascends in the Himalayas and Mehragaon is situated at 4500′ (1370 m).

5. **Whitebreasted Waterhen** *Amaurornis phoenicurus*. This bird was first observed in 1962 at Bhimtal. Since then observations were sporadic, although it was also seen at Naukuchiatal, 4240′ (1292 m). Since about 1969 it has firmly established itself at both these lakes and is now a common resident having displaced the Waterhen (*Gallinula chloropus*) to some extent in the process. According to Whistler (1941), it does not ascend the hill ranges.

6. **Paddybird** *Ardeola grayii*. It was first observed at Bhimtal in the winter of 1969/70. Now a pair has taken up residence and are reported to breed there.

7. **Cattle Egret** *Bubulcus ibis*. This is the most spectacular of the 'new arrivals', as they are so conspicuous. Three of these herons first arrived at Bhimtal in 1970. They were almost always to be seen in the stretch of partly cultivated land, swampy in some places, to the north of Bhimtal, occasionally visiting either Sattal or Naukuchiatal. Now their numbers have increased to a flock of about 12 birds that roost every night in the tall Eucalyptus trees bordering the Bhimtal lake. According to my brothers, they not only breed here but there is another flock of about 12 birds also in the area. Both Whistler and Sálim Ali (1941 & 1946) state that this is a plains bird not found in the hills.

All the birds mentioned above are now conspicuous resident birds that have definitely not escaped observation before. There is therefore not the slightest doubt that these birds are newcomers to the area and have become residents since about 1969. Two other low-elevation species have also been sighted here recently, but I presume that they were stray specimens. The Coppersmith *Megalaima haemacephala*) and the Blackheaded Oriole (*Oriolus xanthornus*). A solitary specimen of the former was observed in January 1972 above Bhimtal at 1475 m (4800′). Sálim Ali (1946) and Whistler give 2500′ (762 m) and 3000′ (915 m) respectively as the height this species ascends to in the Outer Himalayas. A Black-headed Oriole in juvenile plumage was collected at Bhimtal in December 1970.

From the above data one can conclude that many low-elevation species have started extending their range to higher elevations during the past few years. Other observations in the same area support this view. The Green Bee-eater (*Merops orientalis*) has become fairly common now at Bhimtal, where it was formerly a rare straggler. The Blossomheaded Parakeet (*Psittacula cyanocephala*) is also no longer a scarce summer visitor but a common resident at Bhimtal.

On the other hand, high-elevation species such as the Red-crowned Jay (*Garrulus bispecularis*)—formerly a regular winter visitor to the Bhimtal/Sattal region and now absent for some years—and the various Thrushes such as the Greywinged Blackbird (*Turdus boulboul*), the Greyheaded Thrush (*Turdus rubrocanus*) and Tickell's Thrush (*Turdus unicolor*)—formerly very common in winter and now rarely seen—have definitely undergone a change in status here. Another surprising development in this connection is the rapid decline of the Chukor (*Alectoris graeca*) in areas where it once used to be plentiful. The barren hill slopes above Bhimtal and Sattal used to resound to its calls but since the past five or six years it has been neither seen nor heard. No explanation can be given for its disappearance, as its former habitat has not changed and to my knowledge it has been neither hunted nor trapped.

I am unable to give any definite reasons why the abovementioned birds have started extending their range to higher elevations. There has not been any major change in habitat during the past few years and the slow but steady denudation of forests in the hills does not seem to have been accelerated. This denudation however, is not so much due to felling of trees as it is to lopping for fodder and fuel and grazing by cattle and goats, which reduces trees to ' tooth-picks ' and prevents any new growth from coming up. Such a forest is one only by name and not by function. It is possible that this type of deforestation has had at least some effect on the climate of the area, as rainfall at Nainital has gone down from the customary 2700 mm to about 2000 mm per year. Of course these ' changes ' in climate are much too short-term to be taken seriously yet as they could very well be temporary variations caused by other factors ; however, this extension of range by the abovementioned birds, could indeed be interpreted as further evidence that the climate in these hills is undergoing a slow change.

Of course, one could also conjecture that due to various reasons, conditions in the surrounding plains have become less attractive to the birds in question and thus forced some of the birds to ' take to the hills '. This argument is weakened by the fact that the new arrivals seem to thrive here and do not give the impression of being reluctant immigrants.

It would therefore be very interesting to find out whether similar changes have also been observed in the bird population of other hill-stations and if so what explanations can be put forward there.

No noticeable change has been observed in the butterfly population of the region, on which we are also keeping a close watch. However, butterflies, not being as conspicuous as birds, could escape notice if new species begin establishing themselves. Besides, they are generally bound to specific food-plants and would therefore take longer than birds to establish themselves in a new area. Of course, this only applies to butterflies that do not migrate or wander about a great deal.

It is my sincere hope that these 'new developments' within the bird community are not an indication of other, more profound changes to come in the ecology of the area. Even a slight change in climate would be disastrous to the fruit orchards, as the temperate fruit trees growing at lower elevations such as apples, plums and apricots would suffer. What makes the new development so important is the number of species involved, all occupying more or less separate ecological niches.

A much more detailed and thorough study of the above phenomenon is necessary before any firm conclusions can be drawn and then it would be wise to carry out such an investigation within the framework of the general ecology of the area. As neither my family members nor I am in a position to undertake further studies of this phenomenon yet, it was my aim to draw the attention of others to what is perhaps a new problem.

'THE RETREAT',
BHIMTAL P.O. 263136,
DIST. NAINITAL, U.P.,
April 30, 1973.

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3. TAWNY EAGLE AS A SCAVENGER

Eagles are rare birds. They are not common in and around busy cities. Yet a place about three miles south-west of Poona offers a spectacle probably uncommon in any part of the country. On view here is a 200-strong contigent of Tawny Eagles (*Aquila rapax*).

The Tawny Eagle is known to be a scavenger and an opportunist. Its opportunistic behaviour is best seen at this place where waste material from a chicken-dressing plant provides it with regular and easily obtainable food. Abundant food supply has attracted a large number of eagles who feed in the early morning and then spend the day perched on nearby trees and hill-sides. They are well-accustomed to human presence. I have approached them quite close for photography. Their number has apparently deterred vultures.

By their habits birds of prey are solitary creatures. But in this case plentiful food supply has probably reversed this natural tendency. The eagles have become quite sociable and are often seen sitting quite close to each other. It will also be interesting to see if this easy life has diminished their breeding urge. For even during the breeding season, i.e. November to April, no nest was found in the vicinity of this site. Eagles were never seen carrying nesting material or to build nests. In fact a majority of them used to roost at night on nearby hill slopes and apparently never left the site at all. The problem however, needs fuller investigation.

184 SHANIWAR PETH, PRAKASH V. GOLE
POONA-30,
May 18, 1973.

4. STOMACH CONTENTS OF THE GREAT INDIAN BUSTARD, *CHORIOTIS NIGRICEPS* (VIGORS)

The Great Indian Bustard, *Choriotis nigriceps* (Vigors) is one of the most magnificent of Indian birds. Its dwindling population has been a matter of great concern to conservationists for a number of years.

Through the kindness of Shri H. C. Gupta, Divisional Forest Officer, Jodhpur and Shri Y. D. Singh, Zoo Supervisor, Jodhpur, I had an opportunity of examining the stomach contents of a bird caught in August, 1970, near Pokaran (Jaisalmer District, Rajasthan). The stomach was full being filled with *Uromastix hardwickii*, scorpion fragments, sun-spider (*Galeodes orientalis*), beetles (*Gymnopleurus* ? *sindensis* and *Atactogaster* sp.), fruits of *Capparis* sp., and a few seeds of undetermined species. The weight of each item is given in Table 1 below. Before taking the weight the stomach contents had been preserved in rectified spirit and then dried by soaking the moisture on a blotting paper. As such the data is only suggestive of the quantity of food a bird may require for one feed.

TABLE 1

FOOD ITEMS AND THEIR WEIGHT

Uromastix hardwickii (1 ex.)	18·81 gm	17·60%
Scorpion parts	0·70 gm	0·65%
Spider (1 ex.)	3·00 gm	2·80%
Beetles (entire and crushed)	82·27 gm	77·03%
Fruits of *Capparis* sp. (7 exs.)	2·02 gm	1·89%
Seeds negligible in weight		
Total	106·80 gm	99·97%

I am thankful to Dr. B. K. Tikader and Dr. T. G. Vazirani for identification of spider and beetles respectively.

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ZOOLOGICAL SURVEY OF INDIA,
JODHPUR,
February 22, 1973.

5. THE NILGIRI WOOD PIGEON, *COLUMBA ELPHINSTONII* (SYKES) ON SALSETTE ISLAND, BOMBAY

On 17th November 1973, we, along with Mr. Bansi Mehta, sat up in a forest covered valley in the Borivli National Park to see a leopard which was said to pass through the valley. As dusk fell several birds (mainly jungle crows) arrived to roost for the night on the trees in the valley. Among these, we were pleasantly surprised to see a Nilgiri Wood Pigeon *Columba elphinstonii* (Sykes) land on a tree close to where we were sitting. The large size, and ' chessboard ' patch on the hind neck were very definitive. The bird spent the night on the tree and the identification was confirmed when it left early in the morning. The HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN 3 : 133 gives the northern range of the species as ' *c*. 19°N. lat. (a little beyond Bombay) '. A bird of higher elevation[1] it is rarely recorded below *c*. 600 m and the specimen seen was probably a bird in passage. The species is an addition to the birds of Bombay and Salsette Islands.

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6. THE BROWNWINGED STORKBILLED KINGFISHER *PELARGOPSIS AMAUROPTERA* (PEARSON) IN ORISSA

While on a visit to the mangrove forests of the Chandbali coast of Orissa (*c* 20°47'N ; 86°55'E) we saw a large species of Kingfisher unfamiliar to us. A pair was collected and later identified at the Society as the Brownwinged Storkbilled Kingfisher. This remarkably handsome bird was quite common in the area as were the other four species that we noticed, namely the Small Blue Kingfisher (*Alcedo atthis*), the White-breasted Kingfisher (*Halcyon smyrnensis*), Blackcapped Kingfisher (*Halcyon pileata*) and the Whitecollared Kingfisher (*Halcyon chloris*). The latter is also an addition to the Orissa bird list.

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[1] Found at Khandala, Matheran and common at Mahableshwar—Salim Ali.

The Brownwinged Kingfisher has not been recorded south-west of the Sunderbans in West Bengal but is likely to occur in suitable biotopes along the coast south of the present location. A race of the White-collared Kingfisher is known from the west coast of India.

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February 12, 1974.

7. DEVELOPMENTAL PERIOD AND FEEDING HABITS OF BANK MYNA, *ACRIDOTHERES GINGINIANUS* (LATHAM) IN PUNJAB

Developmental period and feeding habits of bank myna, *Acridotheres ginginianus* (Latham) were made during 1970-1972. The birds reared 1-2 broods from Mid April to August, each time laying 2-5 eggs. The incubation was done by both sexes. The egg stage lasted for 13·3 days. Newly hatched young were pink, naked and with eyes closed. Nestlings opened their eyes within 5-6 days. Both sexes fed the nestlings *c.* 15 times/hour. Feathers started sprouting within first week. Nestlings left the nest in 20·4 days. The nesting success was 38.5% (37/96). Fruits of winegrapes (*Vitis vinifera* L.), seeds of pearl millet (*Pennisetum typhoideum* L. C. Rich.), maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), berries of banyan (*Ficus benghalensis* L.), peepul (*Ficus religiosa* L.), carpenter ants (*Camponotus compressus* Fab.), black ants (*Monomorium indicum* Forel.), house-fly (*Musca domestica* L.), rat-tailed larvae of hover fly (*Eristalis tenax* L.), tiger beetles (*Cicindela sexpunctata* Fab.), mole crickets (*Gryllotalpa africana* Beauvois), grasshoppers (*Oxya nitidula* Walker), caterpillars, ground and dungbeetles (unidentified) constituted the food of birds.

The bank myna, *Acridotheres ginginianus* (Latham) which is found only in North India and Pakistan (Ripley 1961) has now become a pest of grapes. The birds puncture and eat the berries and also feed the berries to the nestlings. Notes on the breeding season, nesting habits and clutch-size have been given by Whistler (1963) and Ali (1964). The information regarding the developmental period and month-wise feeding-habits were lacking, and are presented in this paper.

Six colonial nesting sites were selected for studying the developmental period. The feeding-habits of the bird were observed every month throughout the year by direct observations in the field as well as by examining the gut contents of 159 birds[1].

The birds reared 1-2 broods during Mid April-August. Incubation was started as soon as the first egg was laid. The interval between two eggs was 1-2 days. In one nest it was as long as 6 days. Both sexes incubated. The birds sit facing the entrance when incubating. During incubation and early stage of nestling development, the female stayed in the nest at night. The eggs hatched after 13·3 days (n=19)[2] and empty egg shells were thrown off the nest. The hatching of young took place on different days. Newly hatched nestlings were naked (except small white tufts of nestling down on head and back), pink, and had the eyes closed. The eyes opened in 5-6 days. Week-old nestlings excreted when handled; possibly a defensive act. The feathers on the body appeared within a week when the length of tail was 2-3 cm. The white wing patch appeared on 12th day and by 17th day, the whole of the body except the anal area was feathered. Both sexes fed the nestlings and the rate of feeding was 15 times/hour. Nestlings left the nest in 20·4 days (n = 12)[3]. The nesting success was 38·5% (37/96).

The Bank Myna is omnivorous. Grapes which are quite economically important was heavily attacked by the birds in June. During the rest of the year, except for occasionally feeding on pearl millet in the field, insects especially carpenter ants, house-flies, hoverflies, lepidopterous caterpillars, crickets, grasshoppers and berries of peepul and banyan constituted the major part of the diet. Small sized insects e.g. house-fly, ants and caterpillars were found whole in the gut but larger insects like grasshoppers and mole crickets, were broken up. At times, the guts were full with larvae of *Eristalis tenax* L., larvae, pupae and adults of house-fly, lepidopterous caterpillars, grasshoppers (*Oxya nitidula* Walker), carpenter ants and mole crickets. Feeding mostly took place near ditches, ponds, rubbish and dung heaps. The birds also followed cultivators and grazing cattle to take the disturbed insects.

The birds are serious pest of grapes in June and in other months they took mostly harmful insects. It is, therefore, suggested that measures regarding control of birds should be confined to the month of June.

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[1] Except from mid May to mid June (peak nestling feeding period) when 7 birds a week were shot, 3 birds a week were shot throughout the year.

[2] n = 19 n here stands for the number of eggs. The 13·3 days incubation period is the average of the incubation period of 19 eggs of different nests.

[3] n = 12 n here stands for the number of nestlings i.e. 12. The 20·4 days nestling period is average of the nestling period of 12 nestlings of many nests.

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TABLE

FOOD TAKEN BY THE BANK MYNAS IN DIFFERENT MONTHS DURING 1970-71

Month	Food
January ..	Kernels of groundnut (*Arachis hypogea* L.), Seeds of maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), berries of peepul (*Ficus religiosa* L.) and carpenter ants (*Camponotus compressus* Fab.).
February ..	Carpenter ants, pupae and adults of house-fly (*Musca domestica* L.), ground beetles (unidentified), seeds of maize and wheat, berries of peepul.
March ..	-do-
April ..	Carpenter ants, house-flies, berries of peepul and white mulberry (*Morus alba* L.).
May ..	Rat-tailed larvae of hover flies (*Eristalis tenax* L.), carpenter ants, tiger beetles (*Cicindela sexpunctata* Fab.), shells of small snails, caterpillars (unidentified) and berries of banyan (*Ficus benghalensis* L.).
June ..	Fruits of grapes (*Vitis vinifera* L.), rat-tailed larvae of hoverflies, ground beetles, grasshoppers (*Oxya nitidula* Walker), caterpillars, berries of peepul, and banyan.
July ..	Grapes, mole crickets (*Gryllotalpa africana* Beauvois), pupae & adults of house-fly, shells of snails and berries of banyan.
August ..	Kernels of groundnut, field crickets (*Gryllus viator* Kirby), dung beetles (unidentified), shells of snails, black ants (*Monomorium indicum* Forel.) and berries of peepul.
September ..	Seeds of pearl millet (*Pennisetum typhoideum* L.C. Rich.). Berries of banyan and grapes, dung beetles.
October ..	Seeds of maize, wheat, gram, carpenter ants, house-flies, dung beetles, small pieces of pebbles, berries of peepul and grapes.
November ..	Kernels of groundnut, carpenter ants, house-flies and berries of peepul.
December ..	Kernels of groundnut, seeds of pearl millet, maize and wheat, white grubs (unidentified), larvae and pupae of dung insects.

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8. STUDY ON THE STOMACH CONTENTS OF COMMON BAYA, *PLOCEUS PHILIPPINUS* (LINNAEUS)

While studying the stomach-contents of the Common Baya (56 adults and 80 chicks) in the paddy cultivating area, of Orissa and West Bengal, the following observations on the food of the birds were made :

In the case of very young chicks (3 to 6 days), the stomach-contents consisted mainly of weed seeds (Graminiae) and a number of minute stone chips. In some cases, a few broken mollusc-shells were also found. As the chicks grew up (7 to 10 days) a change of food was also noticed. The contents were mostly insect fragments. With development, the intake of mollusc shells increased. The insects were mostly of the Orthoptera group (in nymphal stage). In one case, one egg case of a spider was also found. At the fledgling stage a few soft rice grains could be traced in some cases. Stone chips were still present but gradually their number was reduced in all the stomachs of the developed nestling. The mollusc shells were of two types, Gastropoda and Pelecypoda.

In the non-breeding adults (collected in October from rice cultivation), the stomach-contents consisted mostly of rice grains together with 2 or 3 stone chips in each stomach. In a very few cases, insects were also found. The insects were nymph of Jassids, Hemipterous nymphs and Lepidoptera larvae which were associated with the paddy ear-heads and seemed to have been accidently swallowed. The stomach-contents of the male bird during the breeding season were mostly rice grains, a little amount of insect fragments, few stone-chips and mollusc shells. In one case the number of pebbles was fifteen.

Breeding female : Same as breeding male. In some cases, mostly weed seeds were found, perhaps for feeding new born chicks.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
May 30, 1973.

A. K. MUKHERJEE
B. C. SAHA

9. THE RECORD (?) SALT WATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER)

In January 1973, while on a survey of the status of the Estuarine Crocodile in the Bhitar Kanika Island area of Orissa, off the Chandbali Coast (*c* 20° 47′N ; 86°59′E) we noticed a large crocodile skull in the Palace of the Raja of Kanika at Chandbali. The skull measured 1 metre from tip of snout to occiput and the ratio of skull length to total length generally being 1:7 in this species, the animal when alive would have measured approximately 7 metres (*c*. 23 ft). According to the Raja of Kanika :

> 'This crocodile was about 23 to 24 ft. and was known as *Kalia*. It was very dark skinned. It was very notorious. It had a range of 10 miles in the Dhamra river. It eluded Shikaris for about 50 years. My grandfather, my father's elder brother and my father tried to shoot it. Nobody succeeded. The story goes that it was shot by the Captain of a ship which was on its run from Chandbali to Calcutta. Previously small coasting tramps had regular sailing between Chandbali and Calcutta. The crocodile after being hit and wounded went into the bank where there was a lot of reed and dry grass. The villagers set fire to the grass and the crocodile died. This crocodile was well known to every boatman and every villager.'

The Raja has also given us some interesting information on the Crocodiles of the area which we quote

> In Bhitar Kanika island one could see 30 to 40 crocodiles and if a shooting party went round they could come back with 15 to 20 crocodiles mostly juveniles. We once shot 3 big crocodiles which were 16-footers. This 16 to 18 ft. crocodiles are the standard full grown crocodiles which were found in fairly large numbers. Those which were slightly bigger than these had definitely marked territories about 6 to 8 miles in a reach of a particular river. One may find one big crocodile who will be the monarch of that territory and it will soon become well-known and notorious causing danger to the lives of cattle and human beings specially the cattle. When I was a boy, it was said to be dangerous to wash vegetables, rice etc. by dipping the baskets overboard in the river. It was also dangerous to loiter or stand on the bank near the water specially if the bank is gradually sloping to the water because even if you are 2 or 3 feet from the water, the crocodile will rush with such velocity that you will be caught and the water brought up the bank by the backwash you will lose your balance. They aim at their prey from a great distance may be several hundred feet and dive and come up may be few inches from the target. I had once this experience. I was scanning the river all around to locate a crocodile which had been floating down the river a minute or two before and had gone under water. To my surprise it came up two or three feet from my feet on the river bank. I was saved as there were some formidable stump of the thick mangrove forest after the tops were cut to make a

> clearing rising above the water like a fence between me and the crocodile. It could never had passed through this barrier. The stumps were about 3 to 4 ft. in height. I saw the head of the crocodile for a second or two. The hissing noise of the deep breathing of the crocodile made me look near my feet on the other side of the fence. While I was looking at the river the crocodile had come close to me and I had remained unaware. I was told that this crocodile was 27 ft. It was killed by some East Bengal trappers who used harpoon, torch light and guns for killing such crocodiles for the skin. This poaching is still going on, but as the crocodiles are few now, they do not attract many of these poachers nowadays.

The island of Bhitar Kanika was in the past a sanctuary for the Rajas of Kanika in times of stress. The deep channels surrounding it and its impenetrable forest made it a perfect hide-out. The Rajas in the settled years of this century had converted it into a wildlife reserve and had introduced Sambar and Chital. The fine mangrove forests on the Island are being rapidly removed especially from the side of the western silted channel. The forest on the mainland opposite the east face of the island is also being cut down. There are no forests on other mainland areas opposite the Island.

In our trips along the creeks leading into the Island we were shown several well used crocodile paths leading to belts of thick undergrowth through which the animals had tunnelled in. They are said to stay in this cover. The crocodile that we saw in Shivadri Creek had rushed into the water from one such lair. The presence of juvenile crocodiles probably 3 to 5 months old in the creeks of Bhitar Kanika suggests that this uninhabited Islands is used for nesting by the crocodile. The local forest guards some stationed for many years in the area believe that the crocodiles go up the creeks to lay eggs and that eggs are laid within the forests, but none of the forests guards nor the local people of whom we enquired, have seen the nest or the eggs of the crocodile. However hatchlings have been caught during the rainy season from the heads of the creeks deep within the Island.

During our stay we saw only ten crocodiles (4 adults and 6 juveniles) in an area where they were said to be once abundant and are still considered to be fairly numerous. One of the reasons for the small number seen is probably the large number of country boats loading wood from the bank opposite to the Island and the disturbance that resulted. The areas where they are usually seen sunning themselves at low tide had been abandoned along the main eastern channel.

In a very informative little booklet entitled 'The coast and Tidal Regions of Orissa (Their problem with an approach to Regional planning)' the Raja of Kanika, Shri S. N. Bhanja Deo, speaks of the wild life position in former years especially of the blackbuck herds seen commonly along the sea coast which have now become extinct. The position of wild life has deteriorated and there is no doubt that the crocodiles in the Bhitar Kanika area are also rapidly on the decline and if present conditions persist we do not expect them to last beyond another decade.

We believe there are two main reasons for the decline, habitat destruction and poaching. The estuarine forest composed mainly of mangroves, *Avicennia officinalis, A. alba, Sonneratia apetala, Rhizophora mucronata, R. caudelaria, Ceriops roxburghiana* and littoral species such as *Hibiscus tiliaceus, Xylocarpus obovatus, Excoecaria agallocha, Thespesia populnea, Strychnos nux-vomica* and others are, if timber-bearing, removed for firewood. Wood felling was the major forestry activity in the Bhitar Kanika area during our visit and from the quantity that was being removed in large country boats it was evident that the forests of the mainland to the east and north of the Island would not last long. The forest on the Island, especially that on the west are being surreptitiously removed as they are accessible from across the shallow creek.

The estuarine forest is essential for the crocodile as it provides cover and more important, nesting facility. Removal of the forest would mean automatic extinction of the crocodile.

Poaching directly affects the breeding potential of the population as the large adults are selectively removed. Animals over 4 metres in length are now rare. Crocodiles which were well known in particular localities and used to be shown to visitors have been poached. The method used is harpooning at night when the animals lie out on mudbanks. The poacher shines a powerful torch from a boat on the crocodile lying ashore and the animal instead of escaping into the water keeps moving inland away from the light source making it easy to approach and harpoon and to later recover it from the water. There is very little chance of saving the large crocodiles as long as trade is permitted in crocodile artifacts within the country. Export of crocodile leather is prohibited but not material made out of crocodile leather.

The crocodiles of Bhitar Kanika are perhaps the only remaining representatives of the salt water crocodiles (*Crocodylus porosus*) left in the peninsular area of India. The reason they have managed to exist so far is probably because the area is very poorly developed. To permit this endangered species to continue to exist in the area which has little potential for use by man, it is only necessary to have some minimal management procedures put into effect. The following recommendations may help :

(1) The mangrove forests of Bhitar Kanika Island and surrounding areas should be retained. This would not only help to

preserve the crocodile but also act as a buffer to save agricultural lands lying to their west from the effect of the severe cyclonic storms which periodically ravage the area.

(2) The Bhitar Kanika Island and the surrounding areas should be declared a sanctuary and left inviolate so that the crocodile's breeding areas are undisturbed.

(3) Trade in any form in crocodile skin should be prohibited by the State and Central Governments.

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10. NOTE ON *CRISTICEPS HALEI* DAY, 1888 (PISCES : CLINIDAE) A JUNIOR SYNONYM OF *SPRINGERATUS XANTHOSOMA* (BLEEKER), 1857

Bleeker (1857) first described *Clinus xanthosoma* from Java. Later Günther (1861), Herre (1936, 1939, 1953) and de Beaufort (1951) described it as *Cristiceps xanthosoma* from East Indies and Philippines. Day (1888) recorded a new clinid fish *Cristiceps halei* from Colombo. Since Day (1889) *C. halei* has not been recorded and the type specimen of the species is also not traceable. Shen (1971) recorded it from Philippine and Formosa and created a new genus *Springeratus* for *Clinus xanthosoma* Bleeker.

While collecting shore fishes from Shingle island (Gulf of Mannar), very near to the type locality of *Cristiceps halei* Day, one specimen of *Springeratus xanthosoma* (Bleeker) was obtained. The live specimen was deep orange with three rows of blue spots on the body and a blue blotch over the pectoral peduncle. But this coloration fades in formalin and the preserved specimens are uniformly yellow. Probably this may be the reason for the confusion in the identity of the species.

Cristiceps halei Day and *Springeratus xanthosoma* (Bleeker) from Shingle island differ slightly in fin formula (*C. halei* : D. III, XXVII, 4 , P. 13 ; V. I/2 ; C. 14 ; A. II, 19., *S. xanthosoma* : D. III, XXVI, 6, P. 11-13 ; V. I, 2 ; C. 13 ; A. II, 20) and in coloration (no white marking in *S. xanthosoma*). But these variations are within the range for this species which has a wide distribution from Philippines to Indian coast. However, *Cristiceps halei* Day is not a valid species and is here considered as a junior synonym of *Springeratus xanthosoma* (Bleeker).

As it is the first record of this species from the Indian coast since Day (1889) and as there are some variations, a short descriptions is given.

Family : CLINIDAE

Springeratus xanthosoma (Bleeker)

(Fig. I, A)

Clinus xanthosoma Bleeker, *Nat. Tijds Ned.-Ind.*, **13** : 340, 1857 ; Java.

Cristiceps xanthosoma Gunther, *Cat. Fish. Br. Mus.* **3** : 273, 1871 (compiled). Herre, *Philippine J. Sci.* **70** : 321, 1939 ; Luzon. Weber and de Beaufort, *Fish. Indo-Aust. Archipel.* **9** : 390-391, 1951 ; Java. Herre. *Check-list of Philippine fishes*, 788, 1953 ; Luzon.

Cristiceps halei Day, *Fishes of India*, Supplement : 799, 1888 (Colombo). *Fauna of British India*, Fishes, **2** : 326, 1889.

Springeratus xanthosoma Shih-Chieh Shen, *Rep. Inst. Fish. Biol. Minis. Econ. Affairs Natn. Taiwan Univ.*, Vol. 11, No. 4 : 16-39, 1971.

D. III, XXVI, 6 : A. II, 20 ; P. 11-12 ; C. 13 ; V. 3 ; Ltr. 8/1/38.

Head 23·8 in standard length, 24·1 in total length ; depth 23·8 in standard length and 24·1 in total length. In head length eye 30·0, snout 25·9, first dorsal spine 70·0, second dorsal fin height 30·0, third dorsal fin 50·0, pectoral fin length 70·0, ventral fin 65·0, caudal peduncle 45·0 ; all measurements in per cent.

Mouth upturned, cleft of mouth in line with upper margin of eye ; preopercle with three flat spines, opercle smooth ; gill membrane free from isthmus ; scales cycloid, minute ; cheeks and opercle devoid of scales ; first dorsal fin originates above preopercle, first and second spines long, third spine short and not connected with second dorsal fin which is confluent with third dorsal ; last ray of third dorsal attached to caudal peduncle ; anal fin free from caudal peduncle ; an anteriorly curved intromittent organ with a stout base and pointed tip just posterior to anus (Fig. I, D) ; caudal fin emarginate, caudal and pectoral fin rays not divided ; lateral line originates above opercle, curves below sixth spine of second dorsal fin and terminates on caudal peduncle with 25 tubules ; anterior tubules with double pores and posterior ones with single pore ; nasal opening tubular, nasal cirri divided at tip ; orbital cirri flat, tip divided, 0·75 in eye (Fig. I, B) upper and lower jaws stout ; premaxillary teeth minute, 2-3 rows ; vomerine teeth minute, in two patches on each sides ; mandible with 2-3 rows of acicular teeth (Fig. I, C) ; maxillary membrane present ; gill rakers ten, short, stumpy, with minute simple spines on each side ; only one lower arm of gill arches.

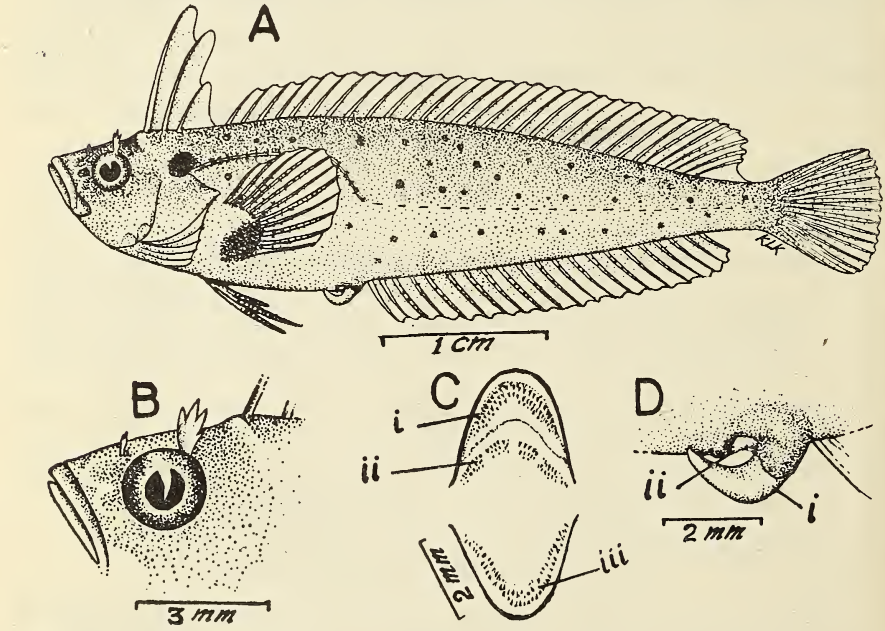

Fig. 1. A. *Springeratus xanthosoma* (Bleeker) CMFRI. No. 119/636 ; total length 49 mm. ; male ; Shingle island (Gulf of Mannar).

B. Enlarged view of upper part of head showing nasal and orbital cirri.

C. Dentition : (i) Maxillary teeth, (ii) Vomerine teeth, (iii) Mandibular teeth.

D. Vent region : (i) Intromittant organ, (ii) Vent.

Deep orange mottled with three rows of blue spots, pectoral peduncle and upper corner of opercle with deep red blotches ; all this colour fades in formalin and the preserved specimen appears yellow.

Habitat : In coral stones and sea weeds along the shore.

Distribution : Philippines, Java, Ceylon and south-east coast of India (Gulf of Mannar).

Material : C.M.F.R.I./F. No. 119/636 ; Total length 49 mm ; male ; Shingle Island, (Gulf of Mannar) ; 24-xii-69.

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MANDAPAM CAMP, TAMIL NADU,
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R. S. LAL MOHAN

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11. ON THE IDENTITY OF RAT-TAILED ANCHOVY *COILIA NEGLECTA* WHITEHEAD, 1967

Whitehead (1967b) described a new species of rat-tailed anchovy, *Coilia neglecta* from the collections of the International Indian Ocean Expedition made during 1963-64, on the basis of one holotype and 10 paratypes. In these eleven specimens the number of post-pelvic scutes is 8-9 ; however, in his key to ten species of *Coilia* (p. 30) he states that in *C. neglecta* the number of post-pelvic scutes is 9-11. In the same key he indicates that the number of post-pelvic scutes in *C. dussumieri* Val. 1848, is 6-8. In the two specimens of *C. dussumieri* described by him earlier (RMNH 7073, Whitehead *et al.* 1966 ; MNHN 3749, Whitehead 1967a), the number of post-pelvic scutes is 8. In the 30 specimens of *C. dussumieri* from Gollapalem (Krishna District, Andhra Pradesh), all of which had pearly spots in fresh condition, the number of post-pelvic scutes is 7-9. According to Whitehead's Key, *C. dussumieri* is distinguished from the other 9 species in possessing pearly spots on flanks. Haneda (1961) identified them as light organs and according to him ' —if this material is preserved in formalin for several months, the golden orange colour of the luminous organ fades away completely, and it becomes almost impossible to recognise the luminous organ on opercular or body surface ' (p. 49-50).

Characters usually employed in distinguishing the species of *Coilia* are : (*a*) number of ventral rays, (*b*) length of maxilla, (*c*) presence or absence of pre-pelvic scutes, (*d*) number of pectoral filaments, (*e*) number of abdominal scutes, and (*f*) gill rakers. A comparison of the characters of *C. neglecta* Whitehead and *C. dussumieri* Val., shows considerable or complete overlap in all biometric characters (Tables I and II) ; the only positive difference between them is with regard to the pearly spots, which are absent in *C. neglecta*. Examination of *C. dussumieri* collected from Gollapalem shows that the pearly spots which are very distinct in fresh specimens disappear partially or completely, after preservation in formalin, as observed by Haneda. Since the description of *C. neglecta* was based on preserved material, and as stated earlier, the light organs in *C. dussumieri* may disappear after preservation in formalin, *C. dussumieri* could possibly be mistaken for *C. neglecta*, while working on preserved material.

A pseudobranch is present both in *C. neglecta* (Whitehead 1967b) and in the specimen of *C. dussumieri* in RMNH (No. 7073), but it was not found in the lectotype of *C. dussumieri* (Whitehead 1967a).

In the circumstances, it is suggested that the validity of *C. neglecta* remains doubtful until some stable characters are found to distinguish it from *C. dussumieri*, because formalin-preserved specimens of

TABLE 1

Character	*C. neglecta* Whitehead[1]	Lectotype, (MNHN 3749) of *C. dussumieri* Val.[2]	Lectotype (RMNH 7073) of *Leptonurus chrysostigma* Blkr. (= *C. dussumieri*)[3]	*C. dussumieri* Val. (Gollapalem, n = 30)
light organs on flanks ..	Absent	Present	Present	Present
pseudobranch ..	present	not found	minute	small (9-11 fil)
branchiostegals ..	10-12	10	8 (?9)	9-11
dorsal rays ..	I iii 10-11	I iii 12	I iii 12	I iii 10-11
pectoral rays ..	vi + 10-12	vi + 10	vi + 13	v-vi + 8-11
ventral rays ..	i 6	i 6	i 6	i 6
anal rays ..	iii 91-107	ii 100 (? 1 or 2 rays missing)	iii 103	100-112
gill rakers ..	17-19 + 23-26	17 + 12[4]	— + 26	17-21 + 24-26
scutes ..	5-6 + 8-9	5 + 8	5 + 8	5-6 + 7-9

[1] Whitehead 1967a.

[2] Whitehead 1967b.

[3] Whitehead *et al.* 1966.

[4] Whitehead (1967a, p. 154) gives the number of lower gill rakers in the lectotype of *C. dussumieri* as 12, this is possibly a printer's devil, because the number of lower gill rakers in this species is much higher.

MNHN : Muséum National d' Histoire Naturelle, Paris.

RMNH : Riksmuseum van Natuurlijke Historie, Leiden.

TABLE 2

Character	*C. neglecta* Whitehead[1]	Lectotype, (MNHN 3749) of *C. dussumieri* Val.[2]	Lectotype (RMNH 7073) of *Leptonurus chrysostigma* Blkr. (= *C. dussumieri*)[3]	*C. dussumieri* Val. (Gollapalem, n = 30)
body depth ..	18·4-20·3	19·7	17·2	18·7-21·7
head length ..	16·2-17·9	17·4	14·2	17·6-19·3
snout length ..	2·6- 3·6	3·4	3·4	3·6- 4·6
eye diameter ..	3.6- 4.1	4·2	3·4	3·7- 4·6
upper jaw length ..	14·0-16·0	16·1	14·6 (15·6)	—
lower jaw length ..	11·5-12·6	12·9	damaged	—
longest pectoral filament ..	31·3 & 37·2-49·0	39·8	damaged	39·4-47·0
pelvic fin length ..	5·5- 6·3	5·7	5·3	5·5- 6·9
length of anal fin base ..	58·8-64·2 & 69·9	60·0	—	—
pre-dorsal distance ..	26·3-27·7	28·5	28·0	25·0-27·2
pre-pelvic distance ..	26·7-29·1	27·2	25·8	23·9-26·6
pre-anal distance ..	37·0-41·6	38·8	37·3	37·3-40·6

[1] Whitehead 1967a.

[2] Whitehead 1967b.

[3] Whitehead *et al.* 1966.

MNHN : Muséum National d' Histoire Naturelle, Paris.

RMNH : Rijksmuseum van Natuurlijke Historie, Leiden.

C. dussumieri in which the pearly spots have become indistinct or have disappeared could be easily mistaken for *C. neglecta*.

ACKNOWLEDGEMENTS

The junior author is thankful to Mr. S. Rama Rao, M.SC., Head of the Department of Zoology, D.N.R. College, Bhimavaram, for the facilities provided and to the University Grants Commission for financial assistance.

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12. SOME SOIL ARTHROPODS COLLECTED FROM PADDY FIELDS AT VARANASI

Very little is known about the mesofauna of Indian soil. The present paper is the result of a quantitative investigation of the mesofauna collected from the paddy fields under drought conditions during September to November, 1966. Soil moisture, soil temperature, and percentage of organic matter was also recorded during the period of investigation.

The sampling plots were located on the Agriculture farm of the Faculty of Agriculture, Banaras Hindu University. Two plots of the size 12 × 12 m were selected and total of 32 soil samples (16 from each plot) were taken during the period of study up to the depth of 22·5 cm at randomized cores with a sampling unit 7·5 × 10 × 22·5 cm in size. Soil was carried to the laboratory in polythene bags. All the soil samples were processed in the Ladell Apparatus (Ladell 1936) by flotation method. The fauna collected and stored in glycerated 70% alcohol, were examined by using a binocular microscope. Oudman's fluid, Diaphane, DPX and Canada balsam were employed as mountant, Lactophenol and Xylol were used as clearing media. On each sampling date additional soil samples were taken from both the plots, from which the percentage of moisture content was estimated by the loss of weight on drying, organic carbon was estimated by diphenylamine method and organic matter by multiplying the organic carbon with arbitrary factor 1·724. Soil temperature were recorded at the time of soil sampling from both the plots at the depth of 11·5 cm using mercury-in-glass thermometer.

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Table I shows that a much higher population of soil arthropods was recorded in Plot I (Paddy field with succulent growth) than in Plot II (Paddy field with fairly advanced growth). Under drought conditions it seems that soil arthropods thrive better in the soil comparatively rich in organic content, and high moisture with low temperature. The mites (Acarina) preferred dry and poor soil, whereas Collembola and Pauropods were found more in rich and moist soil (Table II). Total number of 2705 soil arthropods was collected in 32 samples, of which Acarina were more than 71%.

Table I

Comparison of numbers of soil arthropods from the two paddy plots

Soil arthropods		Plot I Paddy field with succulent growth	Plot II Paddy field with fairly advanced growth	Total
Collembola	..	362	201	563
Acarina	..	1113	817	1930
Pauropods	..	80	33	113
Other soil arthropods	..	57	42	99
Total	..	1612	1093	2705
No. of samples	..	16	16	32
Population/sample	..	100·75	68·31	84·53
Moisture content %	..	5·94	5·04	
Temperature °C	..	26·43	27·28	
Organic matter %	..	0·775	0·647	

Table II

Mean percentage of Collembola, Acarina, Pauropods and other soil arthropods per sample in the two plots

Soil arthropods		Plot I	Plot II
Total No. of samples	..	16	16
Collembola	..	22·46	18·39
Acarina	..	69·05	74·75
Pauropods	..	4·96	3·02
Other soil arthropods	..	3·53	3·84

Among the 28 identified specimens, the 12 Collembola, 11 Acarina and 5 other soil arthropods, collected from the paddy fields are listed in the Appendix.

ACKNOWLEDGEMENTS

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APPENDIX

COLLEMBOLA :

Onychiurus armatus Tulb.
Sminthurus viridis annulatus Folsom
Isotoma viridis Bourlet
Isotomina thermophila Axelson
Isotomina pontica Stach
Isotoma pinnate fasciata Borner
Isotomurus palustria Muller
Folsomia fimltaris Linn.
Folsomides parvulus Stach
Entomobrya santeris Borner
Neanura muscorum Templeton
Seira biformis Mitra

ACARINA :

Typhlodromus sp.
Coccotydeus sp.
Microtrombidium hystricinum
Allothrombium australiense Hirst
Cunaxa setirostris Hermann
Scheloribates sp.
Epilohmannia cylindrica Berlese
Epilohmannia pallida pacifica Aoki
Parasitus consanguineus Oudemans & Voigts
Gamasiphis (*Neogamasiphis*) *bengalensis* Battacharya
Oppia sp.

MISCELLANEOUS :

Tailless whip scorpion
Trithyreus sp.
Japyx sp.
Symphyla
Scutigerella sp.
Scolopendrella sp.
Pauropoda
Pauropus sp.

13. DISPERSAL OF INTERTIDAL SESSILE BARNACLE *TETRACLITA SQUAMOSA RUFOTINCTA* (PILSBRY) BY WATER CURRENTS

(*With two text-figures*)

A report on the occurrence of *Tetraclita* (*Tetraclita*) *squamosa rufotincta* Pilsbry at two localities on the west coast of India (Wagh & Bal 1969) was based on the observations made prior to 1965 and was thought to be a case of stray occurrence. However, further observations at other localities on the Kathiawar Coast of Western India show that these forms are well established in the region. In addition, Utinomi (1969) has recorded their occurrence from Madagascar, Red Sea, Gulf of Aden and Strait of Hormus of Iranian Gulf. Thus, it appears that this subspecies has almost a continuous distribution all along the area extending from east coast of Africa to southern Kathiawar Coast.

In this communication an attempt has been made to explain the dispersal of this non-fouling, intertidal barnacle believed to be an endemic form of the east African Coast (Ekman 1967). It is assumed that this spreading might be through its planktonic larvae in turn carried by the water currents prevailing in this region. Similar dispersal of certain species of echinoderms from East Africa or Red Sea to Hawaii or Outer Polynesia has been reported by Mortensen (1931, 1937, 1938). This assumption is also supported by the observations on breeding activity of intertidal sessile barnacles of the Indian West Coast as well as on the circulation of surface waters in the northern region of Indian Ocean. It has been observed that breeding activity of different species of sessile barnacles found in the intertidal region at Bombay and at other places on the west coast of India is at its highest during March-June and September-October (Pillai 1958 ; Karande & Palekar 1963 ; John 1964 ; Wagh 1965). The circulation of surface waters during these months (Figs. 1 & 2) especially near the Arabian and Kathiawar coasts (Varadachari & Sharma 1967) appears to be helpful for carrying planktonic larvae to suitable locations thereby enabling their settlement.

Thus, there are very strong indications of such a phenomenon taking place although it needs further factual data on breeding behaviour of these forms in particular and examination of plankton samples of the area. It is also expected that further spread of these barnacles along the west coast of India may be possible if their planktonic larvae find the

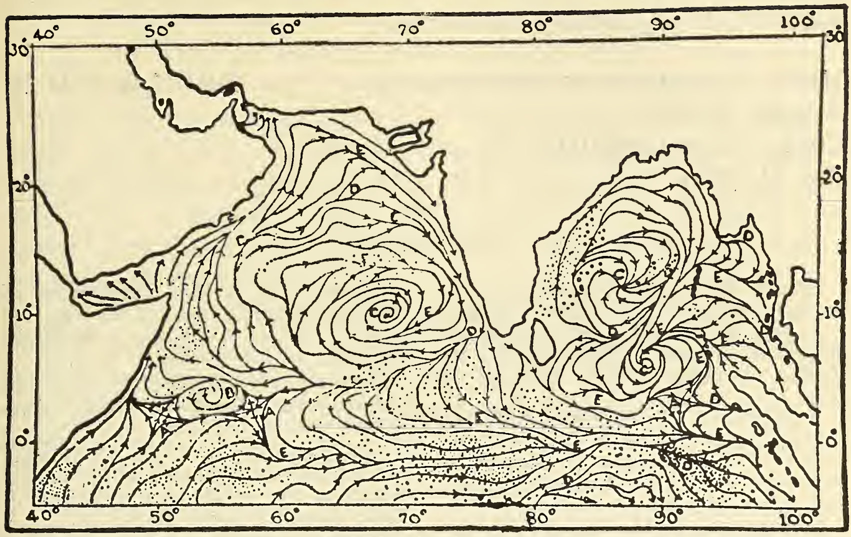
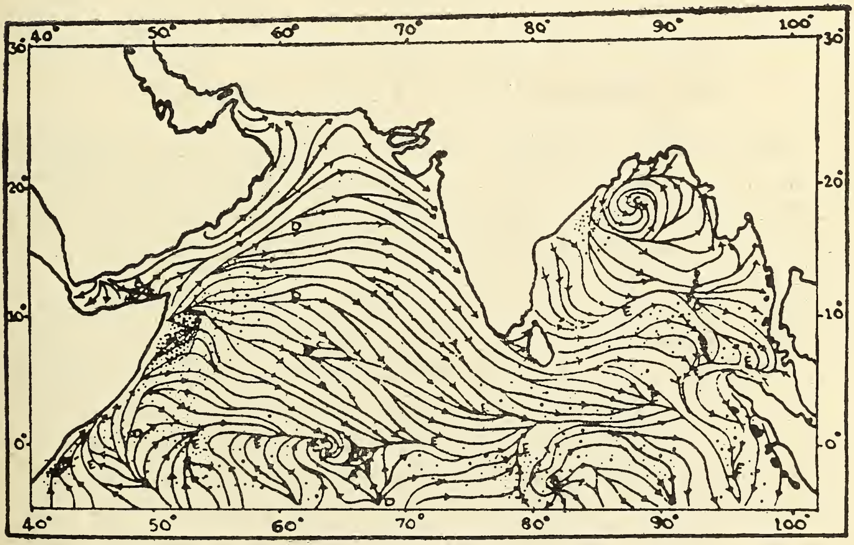

40°
50°
60°
70°
80°
90°
100°
30°
20°
10°
0°
E
D
C
A

Fig. 1


40°
50°
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90°
100°
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D

Fig. 2

Figures 1 and 2 showing the mean surface circulation near the Arabian and Kathiawar coast for the months of April and September respectively.
(after Varadachari and Sharma 1967).

hydrographic conditions in the area between the Kathiawar and Konkan coasts (Gulf of Cambay) favourable.

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14. ABUNDANCE OF FLEAS—A REVIEW

There seems to be nothing unusual in the information communicated by Leonard Woolf in his AN AUTOBIOGRAPHY OF THE YEARS 1904-1911 [*J. Bombay nat. Hist. Soc.* **68** (3): 862], as his observations constitute a mere duplication of similar experiences reported long before him (as far back as the sixteenth century).

Extremely large number of fleas are usually found in uninhabited places like deserted huts, vacant houses, grain storage, vacant godowns, etc. Here the fleas lie dormant within their cocoons for an indefinitely long period until they receive the requisite mechanical stimulus for their emergence. Any disturbance however slight such as vibration caused by the foot-fall of a passing animal or a human being is enough to precipitate hatching, and the fleas burst out in enormous number within a split second. It is also fact that when their cocoons are opened for examination, they are found to contain living fleas. Also, the houses that have been vacant for several weeks may be badly infested with adult fleas, because these insects are able to live without food for a very long period of time. Fleas have been kept living under experimental conditions 'for as long as seventeen months without feeding.'

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Large number of fleas can exist in long deserted huts and houses because in presence of abundant food for the larvae, generations of these insects could be reared in spite of an entire absence of food supply for their adults. The nourishment absorbed during the larval stage is enough for egg production as well as for the development of sperms in the adult fleas. It has also been proved experimentally that 'the fleas can undergo lengthy resting periods in their cocoons under a wide range of temperature and humidity.'

All fleas being negatively geotropic have a tendency to climb upwards and away from the ground. People travelling in the East and in Africa have bitter experience of the abundance and voracity of fleas, and of their clothing being densely covered with myriads of these noxious insects, on entering the huts in deserted villages. It therefore appears that Leonard Woolf had the same bitter experience in Jaffna (Ceylon).

Thousands of human fleas have been captured in the Oriental countries by sending a bare-legged man into a deserted house, and then picking them off his leg. During the Plague Investigations in India (1911) men with bare legs were likewise used to collect the fleas from godowns which had remained vacant for some time. Another way of disposing of fleas in a large number is that of walking about in vacant rooms with fly papers wrapped round the legs. The regular flea collectors usually put on white apparels consisting of white shirts with long tight sleeves, and the shirts are tightly thrust underneath white trousers. They wear long, white stockings covering the trousers upto the knees and their feet are closely covered by white shoes. This facilitates their task of spotting, picking and collecting the fleas.

The 'handful of some herb' given to Leonard Woolf by a 'very old bent Tamil woman' must have been a common wayside bushy odoriferous plant, probably the Fleabane. His great surprise at the so-called 'miracle' was rather uncalled for as such plants and their efficacy have been very well known since ages. The following is a statement given by Butler (1893) on page 263 of his book on 'Our Household Pests':—

> 'That fleas can be excluded from houses by the use of odoriferous plants has long been a firmly believed tradition, witness the name of our common wayside plant viz. the Fleabane. The smoke of this when burnt was held to be particularly distasteful to fleas, which would forthwith abandon any premises in which they detected it. Several species of Compositae have been credited with this potency. A preparation made from the leaves of Pyrethrum from the Caucasus was at one time extensively used in Russia for driving away fleas. Wormwood (*Artemisia*) also was believed to possess similar powers.'

Prof. P. V. Bole, Head of the Botany Dept. of St. Xavier's College, has been kind enough to enlighten me in regard to some of the spp. of *Erigeron* (Fleabane) such as *E. canadensis*, *E. philadelphicus*, *E. heterophyllus*, etc. They all belong to Compositae.

A flea attractor known as the 'flea-fur' likewise used to serve in the past the purpose of getting rid of the fleas. In Europe during the sixteenth century ladies of high rank used to wear the 'flea-fur' around their shoulders in order to attract these agile insects from more vulnerable parts of their person. The fleas thus trapped were later destroyed.

Apart from the human beings some animals also have been said to be possessing the skill of warding off the attacks by fleas. The fox which is fabled for his cleverness, is credited for having devised an ingenious method of ridding himself of fleas. The following are the two extracts from page 156 of a really interesting book on 'Insects Fact and Folklore' by Lucy W. Clausen :—

(1) 'As early as 1634 Thomas Muffett saw a fox pestered by fleas gathering up bits of hair adhering to thorn and briar bushes and rolling them up into a compact mass. Holding one end of this mass firmly between his front teeth, the fox slowly waded backwards into a cold river. In this way he gradually submerged himself until his snout with the mass of hair was just above the level of water. The fleas, in order to get away from the slowly rising water gradually leaped off to congregate in the mass of hair so cleverly held by the fox in his teeth. Finally the fox spat out this flea-laden mass and swam back to the land.'

(2) 'Nearly three hundred years after the great age of Muffett's story, an article verifying the same appeared in the August 5th 1944 issue of the *Saturday Evening Post.* The author of the article who himself had no knowledge of Muffett's experience, reported a similar incident to have taken place in Southern Illinois. The fox in this story collected in his mouth the wool that festooned the barbed wire fence where sheep had brushed against it. When his mouth was fully packed with the wool he trotted off to the edge of a nearby pool, turned round and waded backwards into the water. When he was entirely submerged except for the tip of his nose and the bunch of wool sticking out of his mouth, he suddenly leaped out of the water, dropped the wool and dashed away. Out of sheer curiosity the author of this article walked down to the pool, picked up the wool and found it to be alive with fleas. On communicating enthusias-

tically this information to a friend, the author was retaliated with a story about a pet racoon who rid himself of fleas in a similar manner.'

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15. FORAGING ACTIVITY OF *APIS DORSATA* FAB. ON *BRASSICA JUNCEA* HOOK. AND THOMAS

Like other species of *Apis* bees, *Apis dorsata* Fab. the wild bee, also lives in socialised colonies. Its food requirements as nectar and pollen are constant throughout the year. On account of domestication and management of *Apis cerana* Fab. and *A. mellifera* Linn., their colonies are either moved close to the selected crops serving as bee host plants or they are fed artificially during lean periods by man. *Apis dorsata*, however, migrates from one location to another in search of new crops. It suggests that *Apis dorsata* may be adapted to a large variety of seasonal flowers differing structurally and to the attractants offered by them. Previous experience shows that in the plains of the Punjab and Haryana, *Apis dorsata* is associated with flowers of rape-seed and mustard (Family Cruciferae) during winter (Kapil *et al.* 1969) and with crops belonging to the families Solanaceae, Cucurbitaceae and Leguminosae from summer through autumn (data unpublished). This wide spectrum of adaptation will make behavioural differences by this bee on different flowers and it would be of interest to determine the differential behaviour in relation to the plants with which it is associated. The present study, however, aims to explore the behaviour of *Apis dorsata* on the flowers of raya, *Brassica juncea* Hook. & Thomas.

METHOD

A normal crop of (*Brassica juncea*) raya var. R.L.-18 was selected on the University Farm for observations. The bees visiting the crop on marked areas of 3 square metre were observed and the time each bee took to visit a certain number of flowers was recorded with a chronometer having an accuracy of ± 10 seconds. Temperature and humidity during the hours of observations, ranged between 1·1 to 22·2°C and 42-100%, respectively. The observations were taken at intervals of 10 days.

RESULTS AND DISCUSSION

The four petals of the flowers of *Brassica* are not joined with each other and have nectaries at their bases. The anther sutures face the stigma at the time of dehiscence (Singh 1958). The bee on alighting on the petal should presumably behave in a manner that she could collect her requirements of pollen and nectar and at the same time pollinate the flowers. The posture or attitude she adopts on the flowers would be the parameter, constituting her foraging activity.

Type of visits : *Apis dorsata* foragers have been observed assuming different types of postures on *B. juncea* flowers. These postures for the purpose of pollination have been categorised as follows :—

- (*a*) the bee alights on the petal and inserts her proboscis for nectar once only;
- (*b*) a bee alights as in (*a*) and while holding the genital parts of the flowers, makes a second probe on the opposite end,
- (*c*) a bee steals nectar between the petals without entering the flower.

Of all the behavioural postures, (a) and (b) attitudes appear purposive and evidently useful for the pollination of the flowers. Attitude (b) is superior to (a). Hence a bee performing more of (b) type behaviour will obviously be superior as a pollinator. Table 1 contains the data on the types of behaviour and it is observed that generally a bee performed maximum (b) type visits, only on January 22, 1968 (a) type visits far exceeded the (b). Behavioural indices (a/b) between visits type (a) and

TABLE 1

FREQUENCY OF DIFFERENT TYPES OF VISITS BY *Apis dorsata* ON *Brassica juncea* FLOWERS

Observation hours	Bees observed	Date and type of visits														
		22-1-1968			1-2-1968			12-2-1968			23-2-1968			1-3-1968		
		a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
10.30-11.00	10										4	31	1	11	90	—
11.30-12.00	17							32	143	1	32	257	3	10	135	—
12.30-13.00	25	125	18	5	20	204	—	30	124	10	20	178	—	13	148	—
13.30-14.00	21	45	31	19	7	143	—	8	90	1	47	501	—	5	88	—
14.30-15.00	21	119	47	6	13	160	—	16	138	1	4	100	2	20	140	—
15.30-16.00	25	80	49	3	11	116	—	10	126	—	20	20	1	19	127	—
16.30-17.00	6													14	139	—
Total	125	369	145	33	51	623	—	96	621	13	127	1087	7	92	867	—

(b) varied from 4 to 25 during different hours of the day with larger aggregation between 7-13. The attitudes (a) and (b) are meant to collect nectar by the foragers but the pollen gets accidentally attached to their bodies, for which chances are seemingly more when a bee adopts (b) type attitude. The high frequency of nectar collecting attitudes (Table 1) is indicative of the fact that *B. juncea* flowers are relatively high nectar yielding types. The observation conforms with the data on greater abundance of nectar collectors on *juncea* flowers (Table 2, Col. 4). The flowers need only 14% crossing (Howard & Khan 1915, Singh 1958) and the rest of their pollination occurs through selfing. The data suggests that the high nectar producing property of the flowers, serving as a factor of attractiveness, is probably in some way correlated with their self-compatibility.

Visitation of flowers : Tables 2 and 3 show that *Apis dorsata* foragers started field activity at about 09.30 hr on February 18, 1966, around 10.00 hr on February 23 and March 1, 1968 and at 12.30 hr on January 22 and February 1, 1968. Notwithstanding these variations in the timings, it is observed that the prevailing temperature in all the cases is never less than 15°C at the hour the activity started. Before the hours of activity, the temperature was less than 15°C and the bees did not visit the crop. The higher temperatures, however, do not seem to affect their activity to any great extent. The bees were found coming in fairly good numbers and actively visiting a number of flowers even at 17.00 hr when the temperatures ranged between 21° and 23°C in early March where as they stopped their activity as early as at 16.00 hr when the temperatures were much lower in January and February. It is clear, therefore, that it is not the temperature alone that regulates their activity but there

TABLE 2

NUMBER OF *Brassica juncea* FLOWERS VISITED PER MINUTE BY *Apis dorsata* ON 18.2.1966 (HOURLY OBSERVATIONS)

Observation hour	Temp. °C	Bees observed	Nectar collector	Pollen collector	Flowers visited/ minute
9.35-10.00	15·0	10	9	1	9·23
10.30-10.45	17·0	10	6	4	11·87
11.00-11.15	18·0	8	6	2	11·51
11.45-12.00	20·5	10	8	2	12·39
12.30-12.45	21·0	10	7	3	12·10
14.00-14.15	19·5	10	10	—	10·19
14.45-15.00	19·0	10	9	1	15·04
15.30-15.45	19·0	10	9	1	16·00
				Average	12.29

TABLE 3

NUMBER OF *Brassica juncea* FLOWERS VISITED PER MINUTE BY *Apis dorsata* DURING 1968 (HOURLY OBSERVATIONS)

Observation hour	Observation Dates														
	22.1.1968			1.2.1968			12.2.1968			23.2.1968			1.3.1968		
	No. of bees	Flowers visited/ minute	Temp. °C	No. of bees	Flowers visited/ minute	Temp. °C	No. of bees	Flowers visited/ minute	Temp. °C	No. of bees	Flowers visited/ minute	Temp. °C	No. of bees	Flowers visited/ minute	Temp. °C
10.30-11.00	—	—	10·0	—	—	—	—	—	13	3	7·71	17·5	7	10·92	18·3
11.30-12.00	—	—	12·0	—	—	12·5	6	9·50	15·5	6	11·19	19	5	13·45	21·0
12.30-13.00	4	8·39	15·5	6	11·41	15·0	5	10·76	17·5	5	13·16	20	5	12·69	23·0
13.30-14.00	4	4·73	15·0	4	9·58	15·5	4	11·95	19·0	5	11·65	21	4	14·76	23·5
14.30-15.00	6	6·38	16·0	3	9·64	15·5	3	10·04	19·0	3	16·43	21	6	15·45	23·3
15.30-16.00	3	5·61	15·0	3	7·45	15·0	6	8·15	18·5	7	14·17	18·5	6	14·43	23·5
16.30-17.00	—	—	15·0	—	—	—	—	—	17·5	—	—	17	6	10·97	21·0
Average	—	6·28			9·52			10·08			12·39			13·24	
	Temp. at 11.45 h = 13°C 12.00 h = 13°C Pollen Collector(s) = 1			Temp. at 11.45 h = 13°C 12.00 h = 14°C 12.15 h = 14°C Pollen collectors = 0			Pollen Collector(s) = 0			Temp. at 9.30 h = 13°C Pollen Collectors = 4			Temp. at 9.30 h = 14.2°C Pollen Collectors = 13		

are other factors which actively participate individually and in combination with the temperature. A similar observation was recorded on the field activity of the foragers of *Apis florea* Fab. (Brar 1968).

Tables 2 and 3 indicate that *Apis dorsata* foragers visited an average of 12·30 and 10·79 *juncea* flowers/minute (range 9·23-16·00 and 4·73 to 16·43) and visits were comparatively larger in number at the start of days' activity on January 22 and February 1, 1968 and their visits thereafter decreased toward the end of diurnal activity with some marginal fluctuations occurring during the hours of observation. Observations taken on February 8, 1966 and February 23, and March 1, 1968 show that the number of flowers visited per minute were less in the morning between 09.30-11.00 hr and the number visited increased with the advance of the day and their maximum visits occurred between 14.30 and 15.45 hr. It seems that during the early blooming period (January 22-February 1, 1968) of the crop, the temperature during forenoon was less than 15°C, that affected both nectar secretion and bee activity. During the latter part of blooming period, the temperature rose during early hours and, therefore, the bees started working in the field by about 10.00 hr when the air temperature was around 15°C.

HARYANA AGRICULTURE UNIVERSITY,
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* Paper not seen in original.

16. A NOTE ON THE EARLY DEVELOPMENT OF THE MARINE INSECT *HALOBATES* SP. FROM THE GULF OF MANNAR NEAR MANDAPAM

(*With a text-figure*)

The occurrence of *Halobates* eggs on different floating material has been reported earlier by various authors. A cuttle-bone with eggs of *Halobates* sp. (Fig. 1A) was collected four miles off Vedalai (09° 15′ N, 79° 07′ E) on 24th September 1965. Since there is little information on the *Halobates* eggs and their development from this region, some observations were made on them and are presented in this note.

Several barnacles of the genus *Lepas*, with their shells covered by the eggs of the insect were attached to both sides of the cuttle-bone. A number of polychaetes were also seen in the burrows on the cuttle-bone which suggests that the cuttle-bone must have been floating in the sea for a number of days.

The convex side of the cuttle-bone was more densely covered by the eggs (12 per sq mm) than the concave side (4 per sq mm) (Fig. 1, B). The eggs were embedded in a transparent gelatinous matrix. The eggs were long and uniformly broad with smooth egg membrane. The length varied from 0·64 to 0·87 mm and the breadth 0·35 to 0·41 mm (of Delsmans 1·1 and 0·42). Majority of the eggs were orange-yellow in colour but scattered amongst them were a few patches of brownish-black eggs, evidently in an advanced stage of development. Certain other eggs were yellowish-white in colour with premature embryos inside. These different degrees of development of the eggs clearly indicate that several females must have laid the eggs at different times, on the cuttle-bone as was pointed out by previous authors.

Inside the early stages of eggs which were orange-yellow, the embryo was characterised by three pairs of unsegmented legs, a pair of eyes and the rudiment of the labrum (Fig. 1, C & D) and in the advanced stage of eggs the legs had become segmented and the compound eyes prominent (Fig. 1, E). The cuttle-bone with eggs was kept in running sea water in the aquarium at a temperature of 27·5° C and room temperature of 31·5°C. Transition into the nymphal stage was rapid and the nymphs hatched out on the fifth day after collection. The eggs hatched out in a natural rhythm, batch after batch, as if they had been laid at different times. The nymphs were carefully transferred to a big glass trough containing sea water which was changed once a day. The newly hatched nymphs were pale yellow in colour but turned dark brown in about six hours. The head, thorax and segmented abdomen were distinct. The antennae and mouth parts were well developed (Fig. 1, F & G). The nymphs

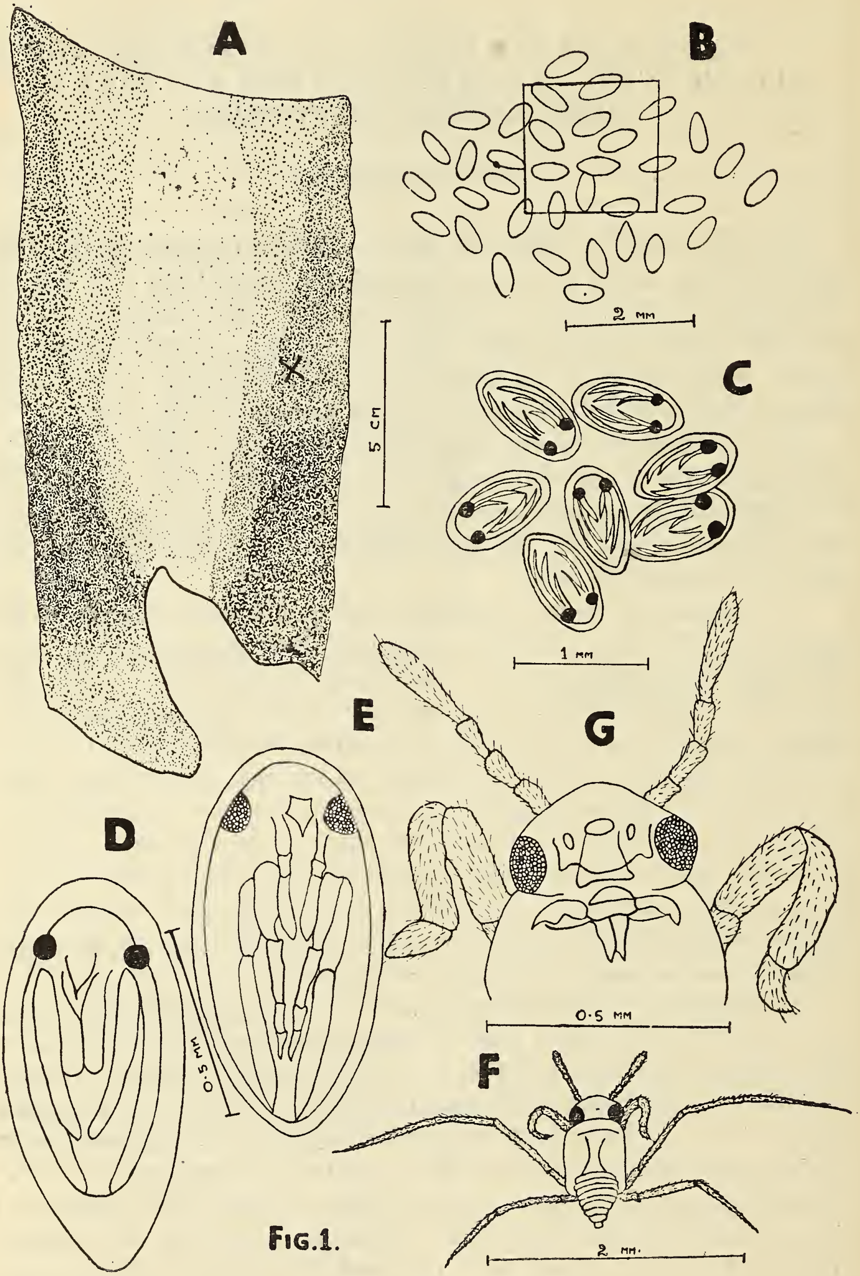

FIG.1.

A. Cuttle-bone showing the intensity of eggs of *Halobates* sp. on the convex side.
B. The arrangement of eggs and their number in one sq. mm (at the area marked × in Fig. 1 A).
C. Early embryos.
D. Enlarged view of an early embryo, ventral view.
E. Enlarged view of a late embryo, ventral view.
F. The nymph (larva) dorsal view.
G. Enlarged view of anterior portion of the nymph, ventral view, to show the mouth parts.

were observed to move swiftly on the surface of the water just like the adult. There was a tendency to prefer the edges of the trough rather than the centre. Attempts to feed them with mashed fresh clam meat suspended in water and alternatively in dry glass trough proved futile. They survived for two days only. The nymphs continued to hatch in good numbers on the first two days but the hatching rate gradually declined and finally ceased on the tenth day after collection.

I am not quite sure as yet to which species of *Halobates* these eggs belong. Herring (1958) has classified *Halobates* into two distinct groups. The ' open Ocean ' group which occurs at considerable distance from land with individuals taken near the shore only after severe storms and the ' coastal ' group with species that are highly endemic to islands or island groups. According to this division the present material in all probability belongs to the second one as they were collected near an island. Herring (1961) observed that twelve days were required for the egg to hatch. The present material hatched out into tiny nymphs on the fifth day after collection. It is reasonable to think that it might not have travelled many miles in about seven days specially when there was practically no storm or heavy winds during this time. Again, as mentioned earlier the eggs containing premature embryos inside suggest that they must have been laid only a few days before collection. Based on these facts it is probable that this insect belongs to coastal group of species.

Gravely (1927) collected some female specimens from almost the same area as the present one and feels that his specimens agree in all respects with White's *H. sobrinus*. But according to Herring (1961, p. 252) ' judging from extensive collections it now appears certain that *sobrinus* is confined to the west coast of America and the Kinberg's label of Tahiti is in error.' Herring in his monograph has described 38 species belonging to the genus *Halobates* and has for 36 species shown their geographical distribution on a map. Among these two species *H. micans* Eschscholtz and *H. flaviventris* Eschscholtz have been recorded close to the area of the present material. Besides these two, *H. formidabilis* Distant has been recorded from the Chilka Lake on the Bay of Bengal by Annandale and Kemp (1915). *H. germanus* White (1883) *H. trynae* Herring (1964) have also been reported from the Bay of Bengal and *H. galatea* Herring (1961) near Bombay on the Arabian Sea.

In a recent paper Lana (1971) has mentioned that ten species of *Halobates* were recorded from the Indian Ocean and the adjacent seas. These include two Oceanic species, *H. micans* and *H. germanus*, and eight species, *H. alluaudi*, *H. formidabilis*, *H. proavus*, *H. tethys*, *H. poseidon*, *H. galatea*, *H. hayanus* and *H. flaviventris*, confined to coastal waters. Comparing the above species to those of Herring's geographical distribution map, we get two species, *H. micans* and *H. flaviventris* which occur close to the place of present material. Lana (1971) has observed that most of the eight species mentioned as coastal are rather restricted in their distribution in the Indian Ocean area but *H. flaviventris* is found from the Bay of Bengal to the coast of Tanzania.

It is probable that the eggs and nymphs described belong to *H. flaviventris* as *H. micans* is considered to be an oceanic species.

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17. BUTTRESS-LIKE STRUCTURES ON THE UPPER PART OF THE TRUNK OF *CEIBA PENTANDRA* (L.) GAERTN.

(*With a plate*)

The White Silk Cotton tree, *Ceiba pentandra* (Syn. *Eriodendron anfractuosum* DC.) is well known for its basal buttresses (Plate).

The object of the present note is to point out the occurrence of wing-like structures resembling buttresses in the angles between the branches and the main trunk, observed in two large specimens of *C. pentandra*, one growing in the Botanical Garden and the other in a private garden in Pondicherry. Buttress-like structures are also observed on the main trunk, having no connections either with the branches or the true buttresses. In smaller trees a tendency towards formation of such structures on the trunk is noted though they are not well formed. The only other tree for which this phenomenon is observed is a Burseraceae, *Canarium commune* L. (Richards 1957).

Buttresses are defined as the supporting roots arising above the ground level and growing downwards and outwards into the ground (Lloyd 1950). Richards (l.c.) defines them as the flat, triangular plates sub-

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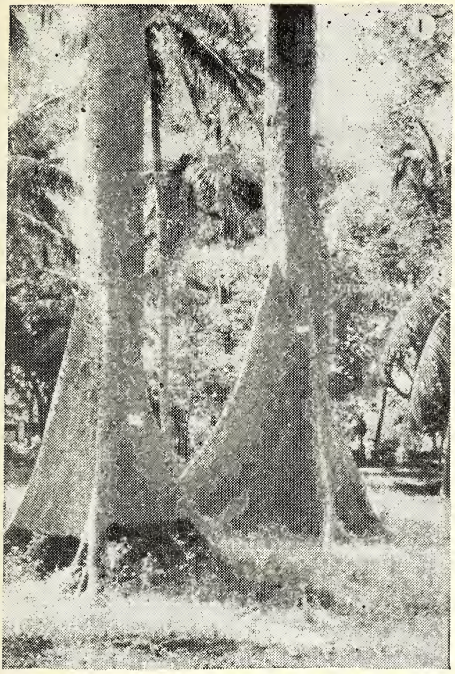

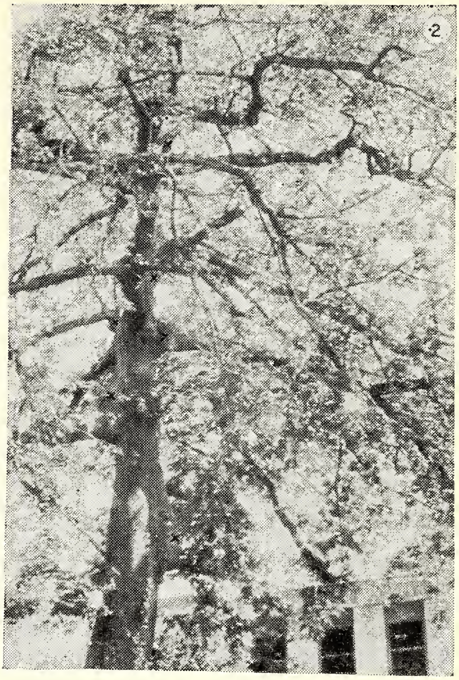

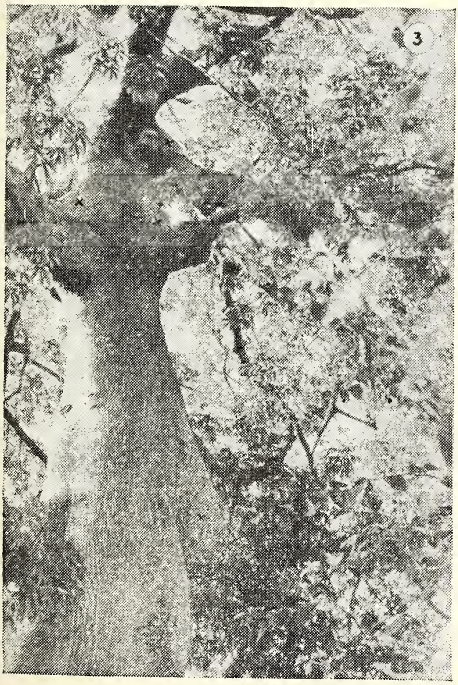

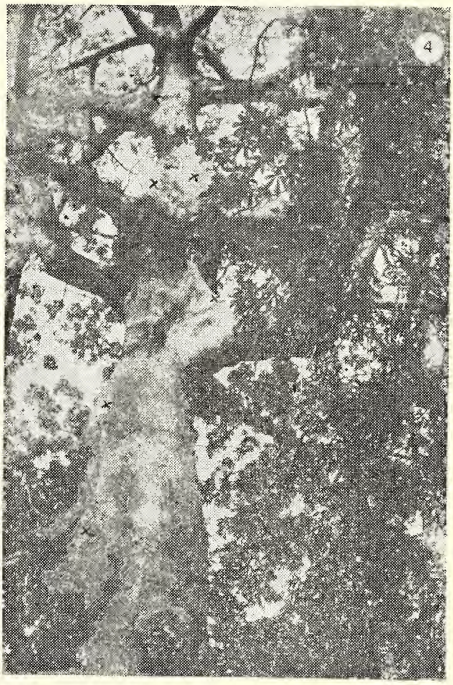

Photos. 1 : Normal buttresses in *Ceiba pentandra* ; 2 : Wing-like structures resembling buttresses (marked with ×) in the axils of the larger branches and on the main trunk ; 3 : Enlargement of the lowermost 'buttress' on the main trunk noted in photo 2 ; 4 : Closer view of the buttress-like structures (marked ×) in the angles between the branches and the trunk, and on the trunk.

tended by the angle between the trunk and the lateral roots running near the surface of the soil ; they are produced by epinastic secondary growth along the upper side of lateral roots. As such the term buttress is inapplicable to the wing-like expansions at the insertion of branches and trunk and on the main trunk noted in *C. pentandra*. However, these structures serve in distinguishing the genus *Ceiba* from *Bombax*, both of which quite resemble each other in leaf and general growth.

The function of these appendages seems to be more or less the same as that of the buttresses. Several theories have been advanced to explain the formation of buttresses (Richards 1957). According to the *adaptation theory*, they enable the tree to withstand both compressive and tensile stresses.

The strain theory akin to the adaptation theory, postulates that the buttress formation is the response of the tree to the mechanical stimulation of strains set up by the wind (Whitford 1906 ; Senn 1923 ; Navez 1924, 1930).

Francis (1924) put forth the *negative geotropism theory* : the upper part of the principal surface roots being affected by negative geotropism and phototropism. Petch (1930) suggested the *conductive current theory* : the transpiration stream bringing in dissolved nutrients from the soil is restricted in the trunk to limited tracts on the same radii as the lateral roots. The currents of water and nutrients encourage growth in the sectors of cambium on the same radii as the lateral roots at the expense of the intervening sectors ; this leads to the formation of ridges which subsequently become buttresses.

Correlations have also been established between the size of buttresses in the most abundant tree species and the texture and the depth of soil (Davis and Richards 1933-34 ; Richards 1957) but for the aerial structures observed in *Ceiba* in Pondicherry, the role of a climatic factor like strong wind associated with the severe depressions of the N.E. monsoon season (October to January) or occasionally with the cyclones occurring from March to May, may be emphasised. In three years—1968 to 1970—there were 13 cyclonic depressions and 7 cyclones on the Coromandel coast involving the months September to December (Legris & Blasco 1974). These structures may have been induced by tension as in the case of true buttresses.

Buttress habit seems to be partly a genetically determined character, inherited by certain taxa only ; even the giant trees like the *Sequoia* of California or the *Eucalyptus* of Australia are devoid of it. Again it is so little developed in the temperate countries subject to violent winds.

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18. STUDIES ON THE LIMESTONE VEGETATION OF SAHASRADHARA NEAR DEHRA DUN (U.P.)—4 'INDICATOR VALUE OF PLANTS'

The probable plant indicators for the mineral calcium have been discussed in this paper.

The studies on the limestone vegetation of Sahasradhara area have revealed certain facts regarding the calcicole and calcifuge plants. Chibber (1945) stated that the rain water charged with carbon dioxide dissolves the limestone rocks and thus the hollows, caves and caverns are formed. Such caves with stalactites and stalagmites are observed along the rocks opposite to the sulphur spring. The soil in these places is calcareous and it is covered with a carpet of plants which include *Adiantum capillus-veneris* Linn., *Pogonatherum paniceum* (Lamk.) Hack., *Primula floribunda* Linn. etc.

According to Puri (1950) 'on new soils e.g., river gravels, shingle islands, or boulder bed, or those which are topographically immature and contain high amount of calcium carbonate (steep slopes and scrap face etc.). Sal community is not present though a solitary tree may be found locally in pockets of mature soils'.

In the present study, the soil samples analysed from the eastern slope, where *Shorea robusta* Gaertn. dominates, are acidic. This is clear from the following data :

Calcium carbonate = 0·75-0·92%

Nitrogen = 0·04134-0·04627%

pH .. 6·1-6·3

Thus the present studies at Sahasradhara agree with those made by Puri (1950) showing clearly that *Shorea robusta* Gaertn. does not grow on alkaline soils.

The surface soils underneath herbs like *Campanula colorata* Wall. ex Roxb., *Eriophorum comosum* Wall. ex Nees and *Galium vestitum* D. Don from the rocky crevices were analysed and they were found to be alkaline. This is clear from the following data :—

Calcium carbonate = 73·15-88·30%
Nitrogen = 0·01790-0·3591%
pH .. 8·3-8·4

This shows that these plants can grow on alkaline soils which possess a greater percentage of calcium carbonate. There are other calcicole plants collected from the rocky crevices namely *Cerbera gossypina* (Roxb.) Raizada and Saxena, *Herminium monophyllum* (D. Don) F. F. Hunt and Summerhayes, *Inula cuspidata* Clarke, *Origanum vulgare* Linn. etc. Further these plants are conspicuous by their complete absence from the eastern slope (*Shorea robusta* Gaertn. belt), which is acidic and deficient in calcium.

Thus the occurrence of *Adiantum capillus-veneris* Linn., *Campanula colorata* Wall. ex Roxb., *Eriophorum comosum* Wall. ex Nees, *Galium vestitum* D. Don, *Cerbera gossypina* (Roxb.) Raizada and Saxena. *Herminium monophyllum* (D. Don.) F. F. Hunt and Summerhayes, *Inula cuspidata* Clarke, *Origanum vulgare* Linn., and *Pogonatherum paniceum* (Lamk.) Hack. exclusively on calcium rich soils shows that they are indicators for the mineral calcium.

The following species have been collected exclusively from the calcareous soils and hence there is every possibility that these species are probable indicators for the mineral calcium *Arenaria serpyllifolia* Linn., *Argostemma verticillatum* Wall., *Begonia picta* Sm., *Bergenia ligulata* (Wall.) Engl. var. *ciliata* (Royle) Engl., *Corallodiscus langinosus* (Wall. ex DC.) B. L. Burtt, *Galium aparine* Linn., *Lindenbergia macrostachya* Benth., *Taraxacum officinale* Weber, *Poa annua* Linn. and *Viola serpens* Wall. ex Roxb.

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19. *NICOTIANA GLAUCA* GRAHAM—A TREE TOBACCO IN MAHARASHTRA

In January 1971 I was informed that there are some plants called in Marathi as 'Mahapurusha' or 'Mahasatpurusha' growing at Kundlapur (Sangli district) whose leaves when chewed produce a sort of hallucination or trance effect and are often used locally for various pulmonary disorders. Subsequently, I visited the locality to collect flowering and fruiting specimens and found that the species belonged to the genus *Nicotiana*. The species identification could not be confirmed since the characters did not tally with any of the four species of *Nicotiana* found under cultivation or as exotics in India (Haines 1922; Patel 1960). Some of the herbarium specimens along with my notes were sent to Royal Botanical Gardens, Kew, England, where they have been identified as belonging to *Nicotiana glauca* Graham.

The species has so far been collected by me from Kundlapur and Jarandi of Kavathe Mahankal Taluka of Sangli District. The plants grow wild about these villages. They do not however form a part of the natural vegetation. Inquiry with the local people revealed that the plants have grown in the area for the last 35-40 years though their importance has been realized only quite recently.

Nicotiana glauca belongs to the subgenus *Rustica*, section *Paniculatae* and occurs in Argentina, Mexico and parts of North America (Goodspeed 1954). Its occurrence in India has not been reported so far and hence a brief description of the species and a key to separating it from other species of *Nicotiana* found in India has been given below.

Nicotiana glauca Graham. A perennial shrub reaching 3 m height. Leaves alternate, petiole 2·5-3·5 cm long, lamina 7-4·5 cm long, 3·5-2·3 cm broad in the middle, margin entire, acute-acuminate, main nerves 6-10 pairs; lower leaves much larger. Inflorescence terminal paniculate raceme. Flowers bracteate, bract about 1 mm long, hairy; pedicel 7-7·5 mm long; calyx (1 × 0·4 cm) tubular, 5-lobed, lobes about 3 mm long, acute, margin ciliate; corolla greenish-white, villose, tube cylindric, 3·2-3·4 cm long, about 4 mm broad, slightly constricted at base, slightly enlarged (5 mm wide) below the lobes; lobes 5, rounded, apiculate, erect. Stamens 5, included, inserted at about 7 mm above the base of the corolla tube, filament 2·5 cm long, cylindrical, anthers bithecous, deeply basifixed dehiscing longitudinally. Hypogynous disk prominent. Ovary superior, ovoid, 2·5 × 2·0 mm, bilocular, placentation axile, ovules numerous. Style 2·5-3 cm long, stigma slightly bilobed. Capsule 0·8-1 cm long, 0·5 cm wide in the middle, dehiscing in four halves from top, enclosed partially or completely in the calyx tube which is often split on one side. Seeds numerous, brownish-black, angular, reticulate. Flowers and fruits. February, July-August.

The species can be easily distinguished from other species in India by its shrubby habit, petiolate leaves and the floral peculiarities as follows :—

Leaves petiolate

Seasonal herbs, calyx teeth sub-obtuse, corolla tube campanulate, yellowish, lobes obtuse...*N. rustica*

Perennial shrub, calyx teeth acute, corolla tube linear, slightly swollen above, greenish white, lobes round apiculate...........................*N. glauca*

Leaves sessile

Corolla tube ventricose above, rosy...........................*N. tabacum*

Corolla tube linear, white or greenish white or pale pink, lobes acute.......... ....*N. plumbaginifolia*

Corolla tube linear, slightly swollen above, white, lobes obtuse..........*N. alata*

ACKNOWLEDGEMENTS

I am indebted to the Director, Royal Botanical Gardens, Kew, England, for confirming the identification and to Dr. B. A. Patil, of Willingdon College, Sangli, for help in arranging the trip to Kundlapur.

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20. AXILLARY ARCHEGONIA IN *SPLACHNOBRYUM INDICUM* HAMP. ET C. MUELL. FROM BOMBAY

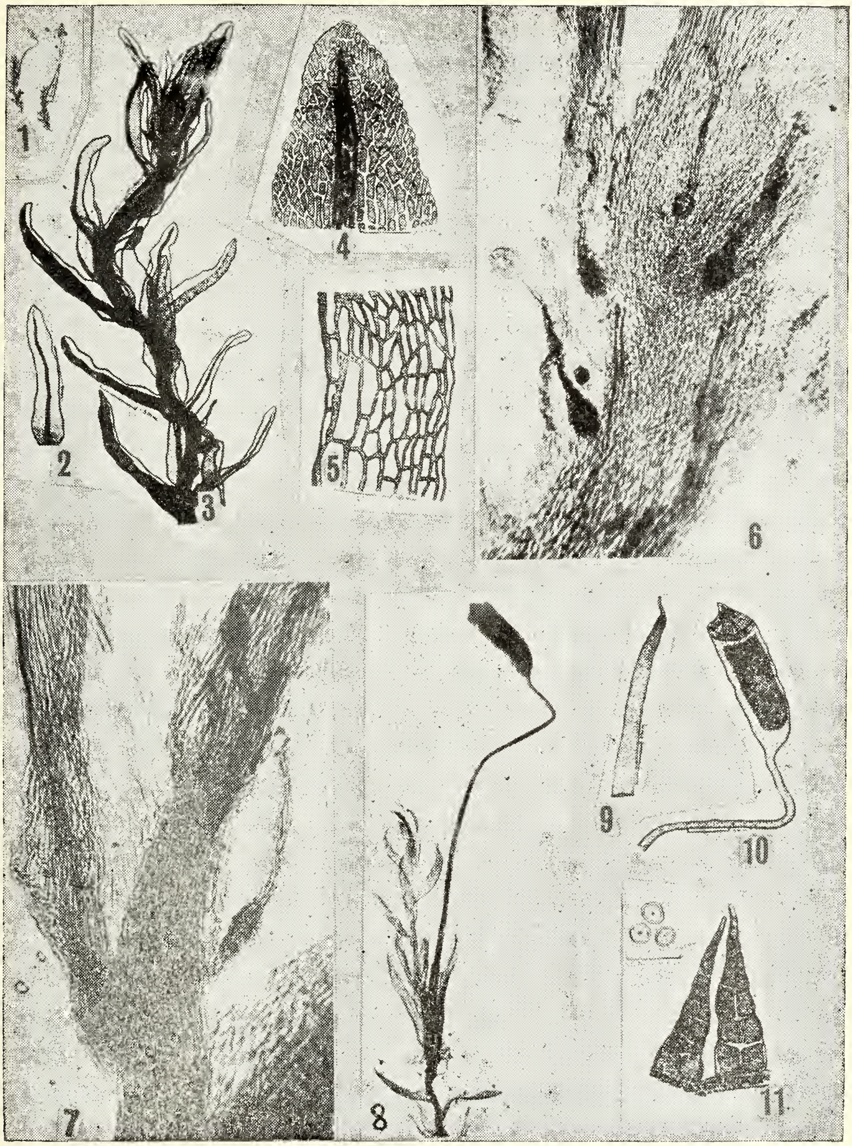
(*With eleven text-figures in a plate*)

The genus *Splachnobryum* C. Muell. belongs to the family Splachnaceae having perstomate capsule, heterogenous nerve and central strand in stem. Five species of the genus occur in India. In two of them *S. indicum* Hamp. et C. Muell. archegonia are found in a position namely axillary or super axillary. Morphologically *S. indicum* Hamp. et C. Muell. (Plate, Figs. 1-11) differs from *S. flaccidum* (Harv.) Braithw. in having erect, lingulate to spathulate leaves (Fig. 2) which are narrower towards the apex, wider at base with undulate margin which is crenulate to serrulate (Fig. 4). The nerve is broad at base and narrow at the apex ending below the leaf apex (Fig. 4). In *S. indicum* Hamp. et C. Muell. leaf cells are thin-walled, chlorophyllose, obliquely rhomboidal, 35 μ long and 16 μ broad. Leaf base cells rectangular to irregularly rectangular, 50 μ long and 20 μ broad (Fig. 5). Seta erect, 1·5 to 2 cm in height, dark brown coloured (Fig. 8), Capsule cylindrical, brownish, with narrow, pointed opercular lid (Figs. 8, 10). Peristome teeth sixteen, deeply inserted, with cleft at base, and narrowed at apex (Fig. 11). Spores brown, globose, smooth-walled, 15 to 20 μ in diameter (Fig. 11). *S. indicum* Hamp. et C. Muell. grows luxuriantly on the old walls of houses and compounds at Mumbra in Bombay. Only female plants are seen.

Careful observations, revealed that there are ten to twelve brownish, long necked, naked archegonia growing in unusual positions on the stem of the female plants. Most of them are lateral in position on stem a few in the axil of leaves and at the apex of stem (Figs. 6, 7). They are stalked (Figs. 6, 7). Well developed sporophytes are formed by them (Figs. 1, 8). Antherdial plants are not seen.

Discussion : Lateral archegonia on stem were recorded in *S. flaccidum* (Harv.) Braithw. from Delhi (Chopra & Rashid 1969). Other mosses like *Atrichum* sp. (Chopra & Bhandari 1959), *Oilgotrichum semilamellatum* and *Lyellia crispa* (Sharma & Chopra 1964), and *Fissidens* sp. also show this anacrogynous condition. In these mosses archegonia are mainly confined to the apices of shoots, but in *S. indicum*

Dabhade: *Splachnobryum indicum*



Splachnobryum indicum (Hamp.) et C. Muell. (Figs. 1 to 11) showing axillary archegonia:

1. Plants under 10 ×. 2. Enlarged view of a entire leaf. 3. Enlarged view of the enlarged part of plant. 4. Enlarged view of leaf apex. 5. Leaf base cells. 6. The axillary and lateral position of the archegonia. 7. Magnified view of a lateral archegonium. 8. Sporophyte arising in axillary position. 9. Calyptra enlarged. 10. Capsule enlarged. 11. Peristome and spores.

Hamp. et C. Muell., it is lateral and axillary in distribution in addition to the normal apical position (Figs. 3, 6, 7). Sporophyte is also present in axillary position (Figs. 1, 8). Apparently this is a unique and very primitive character. Such a lateral and axillary distribution of archegonia. *S. indicum* Hamp. et C. Muell. and other species of *Splachnobryum* resemble with that in the fossil bryophyte-*Naidetia* (Harris 1939) and *Takakia* (Hattori *et al.* 1968). In *Naidetia* archegonia are sessile and lateral in position, but in *S. indicum* Hamp. et C. Muell. they are stalked lateral, axillary and also some apical (Figs. 3, 6, 7).

Some botanists like Campbell (1918) are of the opinion that the development of lateral of axillary archegonia may be due to the repeated anticlinal and periclinal division of the apical growing cell of the stem, but this view is not clearly established with experimental work.

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BANDODKAR SCIENCE COLLEGE,
THANA, MAHARASHTRA STATE,
November 18, 1972.

G. T. DABHADE

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21. ON THE OCCURRENCE OF *ZIZYPHUS GLABERRIMA* SANT. IN NORTHERN INDIA

While working on the flora of Corbett National Park, Uttar Pradesh, we came across a few plants of this species collected at Sarpaduli. The plant has so far been reported in our floras from several areas in Maharashtra State and certain areas in Gujarat State. The present report from Sarpaduli in Uttar Pradesh provides additional information about its distribution in the country and is its first record from areas north of Vindhya ranges. A careful search in herbaria and field may probably provide more data about its distribution in northern India.

The species resembles closely *Z. xylopyrus* Willd., and has been considered a variety (var. *glaberrima* Sedgw.) of it by Sedgwick, Santapau (in Kew Bulletin) ll. *cc.* etc., but differs mainly in that in the present species the undersurface of the leaves is completely glabrous or at most sparsely pubescent on the primary nerves beneath at all stages, the leaf nerves not converging towards the apex of the leaf but remaining parallel from the middle of the leaf upto the apex of the same and the fruit entirely glabrous at all stages. The nomenclature of the plant is as follows :—

Zizyphus glaberrima Santapau in J. Bombay nat. Hist. Soc. **51** : 803, 1953. *Z. xylopyra* Willd. var. *glaberrima* Sedgw. in *Ind. For.* **45** : 71-72, 1919 ; Santapau in *Kew Bull.* 1948 : 489-490, 1949.

The plant is frequently seen in the *Shorea robusta* forest at and around Sarpaduli especially towards the margins of the forests and in jungle clearings. Leaves in our specimens are sub-acute or obtuse or rarely slightly emarginate, the undersurface of which are completely glabrous except for a thinly scattered pubescence on the nerves.

Herbarium specimen examined: UTTAR PRADESH : Sarpaduli, Corbett National Park, 13.11.1970, *P. C. Pant* 43189 (BSD).

ACKNOWLEDGEMENT

We wish to thank Prof. P. V. Bole, St. Xavier's College, Bombay, for help in critically checking the identity of our specimen in Blatter Herbarium, Bombay.

BOTANICAL SURVEY OF INDIA,
DEHRA DUN,
July 28, 1972.

K. P. JANARDHANAN
R. PRASAD

22. STIPULAR CONDITION IN *MAYTENUS EMARGINATA* (WILLD.) DING-HOU

(*With two text-figures*)

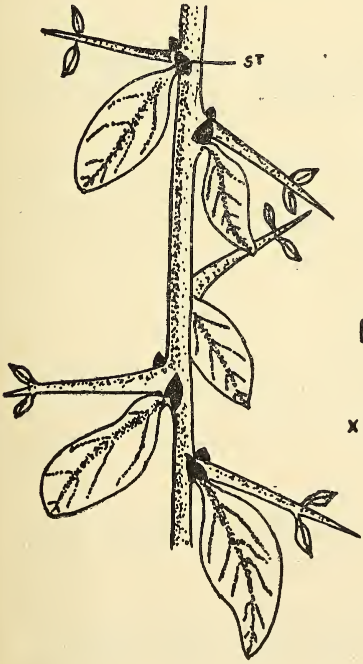
Out of the thirteen species of the family Celastraceae reported from India (Hooker 1872) five genera have stipules in all their species and six genera have no stipules in any of their species as given in the Table 1.

TABLE 1

STIPULATE AND EXSTIPULATE GENERA OF *Celastraceae*

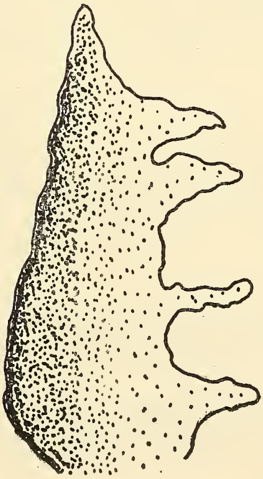
Stipulate	Exstipulate
a. *Euonymus*	a. *Glyptopetalum*
b. *Kurrimia*	b. *Lophopetalum*
c. *Elaeodendron*	c. *Microtropis*
d. *Hippocrataea*	d. *Gymnosporia*
e. *Siphonodon*	e. *Pleurostylia*
	f. *Salacia*

In the genus *Celastrus* certain species are described as stipulate and others as exstipulate. Nothing has been mentioned in the Flora of British India (Hooker 1872) regarding the presence or absence of stipules in the genus *Kokoona*.



FIG·1

x1·5



FIG·2

x100

Cooke (1902), Gamble (1915), and Hooker (1872) described the genus *Gymnosporia* as exstipulate. In our observations of 350 plants of *Maytenus emarginata* (synonym of *Gymnosporia montana*) collected from Vallabh Vidyanagar, Gujarat, the leaf has a pair of scaly outgrowths on either side of its base (Fig. 1). Its size ranges from 0·5 to 0·75 cm. They are caducous, approximately triangular with deeply lobed margins on one side only (Fig. 2). They can as well be designated as stipules, as their function has been observed to be protection of the leaves in young condition. Their stipular nature can also be inferred from their morphological position.

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R.P.T.P. SCIENCE COLLEGE,
VALLABH VIDYANAGAR,
GUJARAT,
July 8, 1972.

P. H. V. VASUDEVA RAO

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23. A FEW UNRECORDED TAXA FOR THE FLORA OF KANYAKUMARI SHORE (CAPE COMORIN), TAMIL NADU

During ecological studies on the coast of India a few plants collected near Kanyakumari shores were found to be new records for this region (Gamble 1915, Nayar 1959 and Lawrence 1960).

BURSERACEAE

Commiphore mukul (Hook. ex Stocks) Engl. A small sized tree with spinescent branches; a common shore plant. No. 8081 (CAL).

FABACEAE

Rothia indica (L.) Druce. A prostrate branched, annual herb. Common on sand along shore. No. 8227 (CAL).

Crotalaria medicaginea Lamk. A small prostrate herb with dark yellow flowers mainly confined to dry sand along shore. No. 8220 (CAL).

Indigofera aspalathoides Vahl. A hoary undershrub with small red flowers frequent on seashore sand. No. 8219 (CAL).

Rhynchosia aurea DC. A slender trailing annual herb with yellow flowers, growing on red sand. No. 8218 (CAL).

Cassia italica (Mill.) Lamk. A diffuse perennial herb with pale yellow flowers, frequent on seashore red sand. No. 8062 (CAL).

Cassia leschenaultiana DC. A suberect undershrub with yellow flowers and brown pods growing on red sand. No. 8222 (CAL).

CUCURBITACEAE

Citrullus colocynthis (Linn.) Schr. A trailing scabrid herb growing on dry sand. No. 8077 (CAL).

FICOIDEAE

Trianthema triquetra Willd. ex Rottl. A prostrate scabrid herb frequent on red sandy soil. No. 8238 (CAL).

RUBIACEAE

Oldenlandia stricta Linn. A tall wiry annual herb common along seashore sand. No. 8228 (CAL).

COMPOSITAE

Launaea sarmentosa (Willd.) Alston. A trailing herb with yellow flower very common on sandy soil. No. 8205 (CAL).

ASCLEPIADACEAE

Hemidesmus indicus (Linn.) Schult. A twining undershrub with dimorphic leaves growing frequently on seashore red sand. No. 8236 (CAL).

Pentatropis capensis (Linn. f.) Bullock. A slender climber with purple flowers spreading on *Commiphora mukul* Engl. along shore. No. 8204 (CAL).

Pergularia daemia (Forsk.) Choiv. A slender milky climber growing along hedges. No. 8076 (CAL).

BORAGINACEAE

Heliotropium scabrum Retz. A small prostrate scabrid herb or undershrub with strigose leaves and white flowers. No. 8229 (CAL).

ACANTHACEAE

Blepharis moluginifolia Pers. A prostrate small wiry undershrub with blue flowers, growing along seashore sand. No. 8203 (CAL).

LABIATAE

Geniosporum tenuiflorum (Linn.) Merr. A prostrate herb many branches from a woody root stock ; leaves hispid and glabrous ; growing on rocky coast carpeted with sea sand. No. 8224 (CAL).

CHENOPODIACEAE

Atriplex stockesii Boiss. A undershrub with long procumbent branches ; Obovate leaves completely covered with white shining scales ; common on granite rocks along seashore. No. 8097 (CAL).

ARISTOLOCHIACEAE

Aristolochia bracteolata Lamk. A perennial herb with greenish corolla tube and purple lip ; common on granite rock crevices along seashore. No. 8201 (CAL).

EUPHORBIACEAE

Phyllanthus rotundifolius Klein. A prostrate fleshy herb with stout root stock and trailing branches, common on seashore sand. No. 8232 (CAL).

Phyllanthus maderaspatensis Linn. A decumbent herb with woody root stock. No. 8096 (CAL).

Euphorbia thymifolia Linn. An annual prostrate herb with hispid hairy stem. Rare on sand. No. 8095 (CAL).

Euphorbia rosea Retz. A prostrate herbs with long root stock and beautiful pink flowers ; common on shore sand. No. 8233 (CAL).

LILIACEAE

Scilla hyacinthina (Roth) Macbr. A scapigerous herb with white globose bulb and purple flowers. Common on granite rocks covered with sand along sea coast. No. 8090 (CAL).

CYPERACEAE

Fimbristylis cymosa R. Br. An erect rigid sedge, leaves crowded on the short rhizome stock ; a good sand binder ; Common on shore sand along sea coast. No. 8210 (CAL).

Cyperus pachyrrhizus Nees. A sedge with robust, trigonous stem covered with chestnut coloured scale ; rootlets densely woolly ; Common on rocky back shore. No. 8207 (CAL).

Cyperus rotundus Linn. A tuberous sedge with trigonous stem frequent on seashore sand. No. 8240 (CAL).

GRAMINEAE

Manisuris myurus Linn. A perennial tufted grass, on sandy shore No. 8221 (CAL).

Sporobolus maderaspatenus Bor. A perennial erect grass with narrow pointed convolute leaves ; growing frequently on rocky shore on calcareous sand. No. 8066 (CAL).

Perotis indica (L.) Kuntze. A tufted, wiry grass geniculated at base, common on sand. No. 8067 (CAL).

Eragrostis coarctata Stapf. An annual or perennial grass with narrow flat leaves and panicled spikelets ; Common on shore sand. No. 8065 (CAL).

Eragrostis riparia Nees. A slender annual with narrow leaves. Common on rock sand. No. 8100 (CAL).

Pennisetum pedicellatum Trin. A perennial, tall, branched grass with narrow flat leaves, common on seashore sand. No. 8242 (CAL).

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May 6, 1972.

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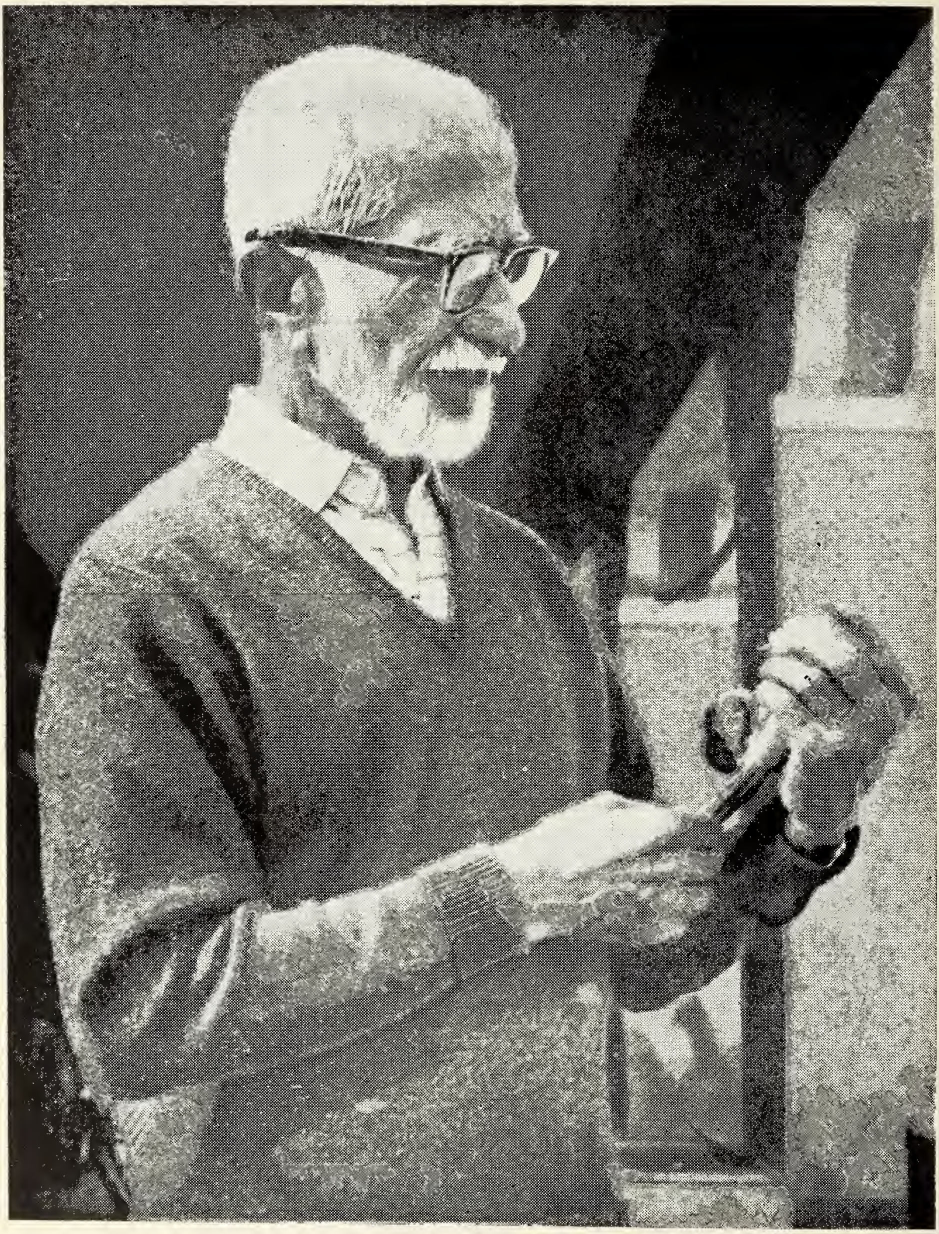

Sálim Ali at Bharatpur, March 1969.
(*Photo*: *V. S. Saxena*)

JOURNAL

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BOMBAY NATURAL HISTORY SOCIETY

1974 DECEMBER Vol. 71 No. 3

Prefatory Note

It is now two years since Sálim Ali's 75th birthday, which this volume was to commemorate. Instead it will be appearing in his seventy-eighth year. Hale and hearty, our distinguished Sálim Ali and the author with trekking party and family recently celebrated his seventy-seventh birthday in the field, studying birds in Bhutan. On that occasion the author composed a jingle which expresses some of this contributor's admiration for the doyen of Indian ornithology.

S.D.R.

ODE TO SÁLIM ON HIS SEVENTY-SEVENTH BIRTHDAY

12 November 1973, in camp, Bhutan

From the Wakhan and the Rann
    To Point Calimere and Kandy
In monsoon rain or sun,
    In dak bungalow or dandy,
Wherever there are birds
You will hear the reverent words :
    Oh Sálim's our hero, Sálim's the man
        Whose knowledge is always on tap.
    The terror of wrens, Finn's Baya's fan,
        A truly remarkable chap.

So ho for the Wedgebilled Wren
  And hey for the tragopan hen ;
So ho for the *tweet tweet tseep*
  And hey for the leopard's cheep.[1]
Let's squeak like Blewitt's Owl
And honk like water fowl
  As through thicket, bog and heather
  We hunt for Hume's stray feather.
  Oh Sâlim's our hero, Sâlim's the man
    Whose knowledge is always on tap.
  The terror of wrens, Finn's Baya's fan,
    A truly remarkable chap.

For our part we know his knowledge will glow
  For ages to come, his lamp will shine out.
His birthday we sing while pheasants all crow
  And birds of all kinds join in tuneful shout.
Nor Hodgson nor Baker knows more about life
  Nor Coltart nor Inglis have weathered the strife
About bird lore and bird song with steadier light
  Than our hero whose birthday we welcome tonight.
  Oh Sâlim's our hero, Sâlim's the man
    Whose knowledge is always on tap.
  The terror of wrens, Finn's Baya's fan,
    A truly remarkable chap.

---

[1] Laboured. This reference is to the man who discribed the call of Molesworth's race of Blyth's tragopan, from where it sat in the middle of a bamboo clump, as sounding like a leopard ! One of our pet jokes.

Introduction

S. Dillon Ripley

The concept of dedicating a special issue of the Bombay Natural History Society Journal to Sálim Ali on the occasion of his seventy-fifth birthday is an eminently sensible one. Sálim Ali has been the moving spirit behind the Society and its publications for more time than most of us can visualize. It is indeed right that these contributions by his friends and colleagues should appear in the pages of the Journal which he has helped to shape for so many years.

The Journal is a journal in many unexpected ways, having survived the middle years of this Century successfully, the years when there was a temporary decline in the prestige of the term *natural history*. The early years of this Century were still dedicated to the necessary surveys and summaries of taxonomical reviews and field notes. It was Sálim Ali himself who introduced the more modern-day concepts of ecology to India. His papers, appearing in this Journal, on life history and behaviour of birds in the Survey series, and his notes on the biogeography of India as expressed in recent historical zoology, helped to revolutionize Indian biology, no less than his *Book of Indian Birds* helped to awaken the minds of countless Indians as well as foreigners to the delights of field observation.

And so Sálim Ali has spanned the generations from the days of the amateur and sportsman, many of them British, but not a few famous shikaris of Indian parentage, in the first years of the Bombay Society, to the present day when ecology has come into its own, and *natural history* in the best sense has had a renaissance all over the world. It is, therefore, a special privilege to help to preside over this issue for one who not only holds Sálim Ali in the highest esteem as a great scientist, but also holds him in affection as a close friend. Scholars and scientists alike in India will always treasure Sálim Ali's contributions in science as well as in humanity.

The list of contributors is long and would have been longer were it not for the heavy burdens of many of our colleagues. We greet with sadness the recent death of one of the most notable contributors, Professor Stresemann, and we mourn the loss of another colleague David Lack, who would have contributed but for the preoccupations of a fatal illness. We regret that others have found it impossible to be present in these pages, all admirers and friends of Sálim Ali ; Bernhard Rensch,

K. S. Dharmakumarsinhji, A. I. Ivanov among them. But the felicitous Dr Yoshimaro Yamashina has commented on his noted colleague as follows: 'I am awfully pleased to have heard that a "Festschrift" volume is to be published honouring the 75th birthday of our good friend, Dr Sálim Ali. I am delighted and wish to join your suggestion and will write a short article for its memorable publication of my friend of long standing.'

The papers included in this assemblage are from a variety of authors representing Sálim Ali's wide range of personal interests and friendships. Some are essentially biographical as those of Messrs Futehally and Yamashina. Others are concerned with comparative field observations as those of Dr McClure and Professor Dorst where two types of similar habitats and their accompanying faunal differences are described. Zoogeographical considerations are the preoccupations of Messrs Abdulali and Delacour and Dr Biswas. The late Professor Stresemann describes a provocative systematic problem of presumably sibling populations of the same species, while Professor George considers the physiological phenomena concerned with a migratory population. Two authors speculate on the biology or changing distribution of bird species; Dr Friedmann in preparation perhaps for more field work on honey-guides and Mr Horace Alexander in connexion with problems of human interference with the landscape.

In connexion with Sálim Ali's interest in migratory studies of birds some of his Russian colleagues, Professor Netsky and Dr Malkov and Dr Bogdanov, have contributed a paper on tick-borne arboviruses, while Dr Theresa Clay has speculated on avian lice and their speciation in connexion presumably with environmental modifications of host species. An additional migration study based on ringing returns is that of Sir Landsborough Thomson on the Gannet. Vocalization in birds is the subject of two papers by Professor Thorpe and Dr Brian Bertram, while field biology of a warbler, and competing swift species are the topics of Professor Gavrilov and Dr A. F. Kovshar, and Professor Tom Harrisson, the expert on the Niah caves of Sarawak.

One of Sálim Ali's most notable contributions in field biology is represented by a paper by Professor T. A. Davis. This is a paper on the Baya, and its selection of nesting sites. The breadth of Dr Sálim Ali's interests is represented by the contribution of Professor Altevogt and Dr Zeller on visual learning in the Tree Shrew, *Tupaia glis*. A paper on the distribution and numbers of the Great Bustard, *Otis tarda*, of Eurasia, by Dr Isakov, completes the series.

In my own case I can only contribute a continuing interest in high-altitude observations in the eastern Himalayas. I have reported briefly on observations made in Bhutan in 1968 while on a joint field trip, undertaken at Sálim Ali's behest (Proc. XV International Ornithological Congress, The Hague, 1972, pp. 682-3), and continuing in 1973. It is my hope eventually to join with him as well as Dr Biswas in publishing our Bhutan observations, as well perhaps as notes on comparative ecology of migrant and resident species. Meanwhile our work together on the Indian *Handbook* has been my own reward for the privilege of knowing this felicitous man.

Selection of nesting trees and the frequency of nest visits by Baya weaverbird[1]

T. ANTONY DAVIS

Indian Statistical Institute, Calcutta

(*With five figures*)

INTRODUCTION

Dr Sálim Ali inspired me to study birds. I am particularly delighted, therefore, to have an opportunity to join colleagues to felicitate this eminent ornithologist on this auspicious occasion by presenting a paper. Dr Ali was the earliest to investigate thoroughly the nesting habits of the baya weaverbird *Ploceus philippinus* (L.). I consider it appropriate, therefore, to report here some of my own observations on this fascinating species, so dear to village folk of India.

The baya weaverbird, noted for its complex, retort-shaped, dangling nest, woven with strips of grass and palm leaves, is familiar throughout the Indian subcontinent and the adjoining countries of Pakistan, Bangladesh, Burma, Thailand, Malaysia and Sri Lanka. The adult male baya is sparrow-like but streaked with brown, and with a thick bill and short rounded tail (Fig. 1). Being sexually dimorphic during the breeding season, the male acquires golden yellow plumage on the breast and head. The female is more drab, rather like a hen sparrow but for her stouter bill and shorter tail.

In India the baya selects a variety of trees, shrubs and other sites for nesting, the most favoured among them being the thorny acacias and certain species of palms. Moreover, the birds in each particular region seem to prefer a particular type of nesting site. To understand the reason for such a preference, I toured over all the Indian states and recorded as many baya colonies as possible. Details on the survey are summarized in this paper.

The baya nest is woven almost exclusively by the male who acquires a mate when the nest reaches the "helmet' stage. The pair live together until the female has stopped laying and begins to incubate the clutch of 2-4 eggs. By this time the male completes the nest-weaving, including the tubular entrance. The hen hatches the eggs and feeds the young

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[1] Received December 1972.

practically on her own. Detailed records were kept by watching the birds continuously for over 12 hours daily on the nest-building activities of males in a colony in a suburb of Calcutta, and the activities of hens brooding the eggs and nursing the young were also recorded. Details on the nest visits of the male as well as the female baya are also discussed in this paper.

HOST TREES, SHRUBS AND STRUCTURES OF BAYA COLONIES

The baya weaverbird in India has been found to colonize a surprising variety of plants. Structures like house eaves (Davis 1971a), telegraph and power lines (Ambedkar 1970), the sides of irrigation wells (Ali 1931, Crook 1960a, 1963) are occasionally selected for hanging their nests. When first travelling from the southern tip of India (Kanyakumari) to Calcutta in 1960, in observing the host plants of the baya, I felt that the birds of different regions seemed to prefer different species of plants for colonization. So I decided to make a survey of the Indian subcontinent covering all the states for studying the host range of baya colonies. During the following six years, I covered about 15,000 km in various states almost exclusively for observing the baya colonies by travelling in slow-moving trains, omnibuses, bullock carts or on foot. I should mention here that the survey was not designed statistically and so I might have covered proportionately more area in one region/state than in the others. But the proportion of the different host plants would remain more or less the same within a given region. Such a proportion between some states varies considerably.

Altogether 1485 colonies were recorded as shown in the Table. The number of nests per colony varied from one to about two hundred and fifty. About forty different species of plants were found to carry baya nests. Mathew (1972) has added a species to this list. In Uttar Pradesh alone, at least 25 species of plants were colonized.

It is clear from the Table that plants having prominent thorns, prickles or similar devices which may act as deterrents to predators, notably marauding monkeys and snakes, have attracted the baya most. About 68 per cent of colonies were located on such trees beset with thorns, prickles and similar defensive structures, besides those on electric or telegraph lines and inside irrigation wells which are very well protected from most predators. In some cases the nesting trees were not themselves spiny but were surrounded by thick brambles. The coconut (*Cocos nucifera*) and the areca palm (*Areca catechu*), both without spines, together account for about 15 per cent of the plants which were preferred in two regions for nesting. The tall, unbranched, smooth trunk and the long, swaying leaves which keep away many predators and provide a convenient source of leaf strips for weaving may compensate for lack of

TABLE

HOST PLANTS AND STRUCTURES FOR BAYA COLONIES IN DIFFERENT REGIONS OF INDIA

Plants/structures	Assam region	Andhra Pradesh	Bihar	Gujarat	Haryana & Delhi	Jammu & Kashmir	Kerala & Karnataka	Madhya Pradesh	Maharashtra	Orissa	Punjab	Rajasthan	Tamil Nadu	Uttar Pradesh	West Bengal (south)	Total
1. *Acacia* sp. ..	—	90	—	33	41	9	—	33	6	2	32	42	9	119	6	422
2. *Phoenix sylvestris* ..	1	242	7	—	29	1	—	20	5	9	2	—	14	33	—	363
3. *Borassus flabellifer* ..	—	32	16	—	—	—	17	—	4	15	—	—	15	12	64	175
4. *Areca catechu* ..	114	—	—	—	—	—	—	—	—	—	—	—	—	—	—	114
5. *Cocos nucifera* ..	5	3	—	—	—	—	64	—	—	3	—	—	24	—	3	102
6. *Zizyphus jujuba* ..	—	1	—	5	5	2	3	10	6	—	1	—	—	12	—	45
7. *Dalbergia sissoo* ..	2	—	—	—	5	—	—	—	—	—	10	5	—	14	—	36
8. *Prosopis* sp. ..	—	14	—	—	2	—	—	2	—	—	—	—	—	3	—	21
9. Tall grasses ..	—	—	—	—	5	1	—	—	—	—	3	—	—	9	—	18
10. *Butea frondosa* ..	—	—	—	—	3	5	—	—	—	—	4	—	—	5	—	17
11. Sides of wells ..	—	1	—	1	1	—	—	1	5	—	—	3	4	—	—	16
12. *Pithecolobium dulce* ..	—	8	—	—	—	—	—	—	—	—	—	—	—	1	—	9
13. *Tamarindus indicum* ..	—	3	—	—	—	—	—	—	—	1	—	—	—	—	—	4
14. Telegraph lines ..	25	—	—	—	—	—	—	—	—	—	—	—	4	3	—	32
15. Power lines ..	1	—	—	—	—	—	—	—	—	—	—	—	3	—	—	4
16. Others : thorny plants ..	3	—	4	—	—	1	3	—	3	—	1	2	2	14	4	37
17. Others : unarmed plants ..	4	2	6	2	3	—	7	—	—	1	1	2	—	23	1	52
18. Unidentified species ..	—	—	—	1	2	1	2	—	—	—	2	—	—	1	—	9
19. Eaves of houses & walls ..	—	—	—	1	—	—	2	—	—	—	—	—	—	6	—	9
Total ..	155	396	33	43	96	20	98	66	29	31	56	54	75	255	78	1485

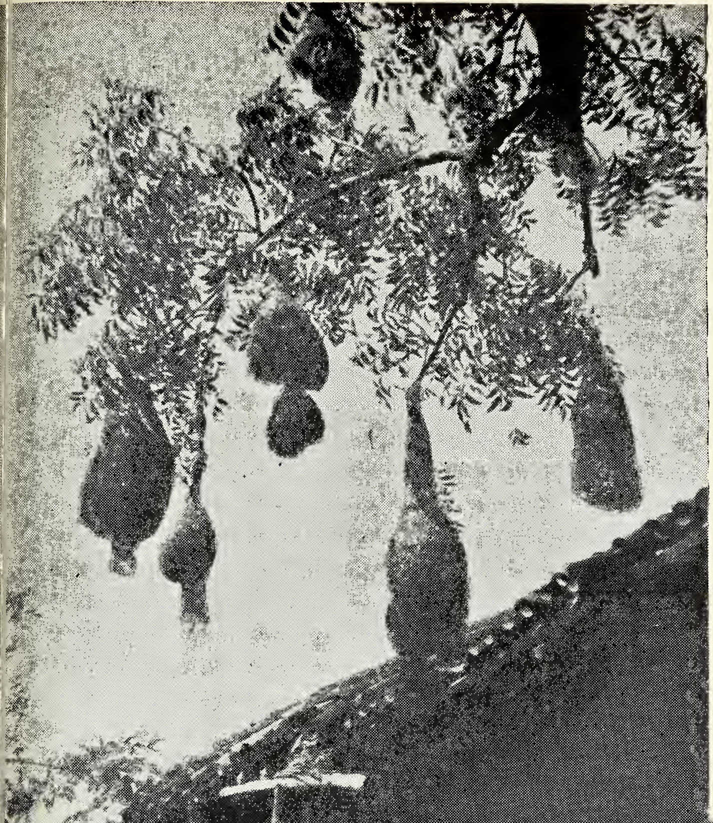

Fig. 2.

A large colony on a margosa tree standing close to a house. Nests are also hung on the roof of the house.

(*Photo*: *Author*)

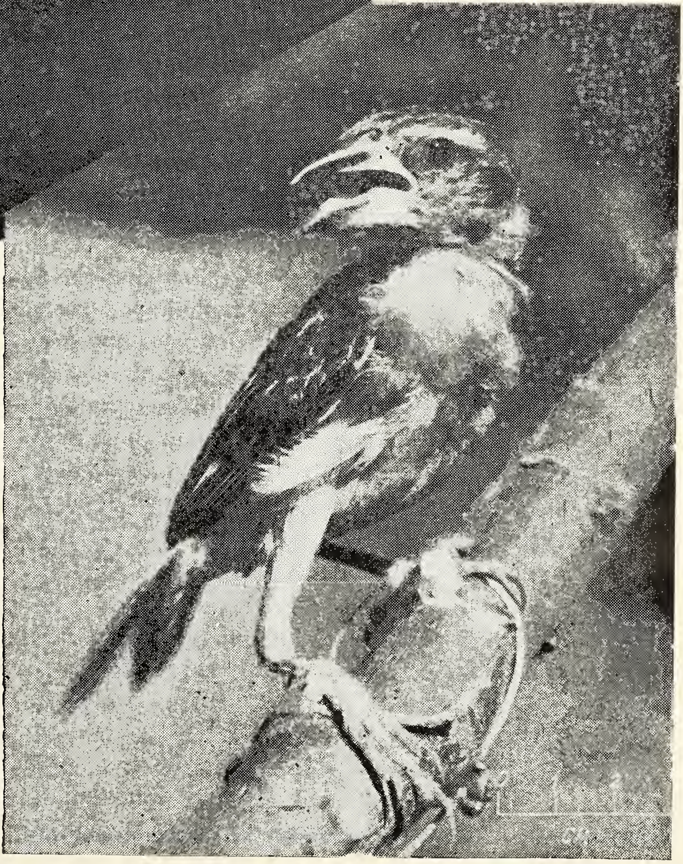

Fig. 1.

male baya weaverbird
n nonbreeding plumage.

(*Photo*: *Author*)

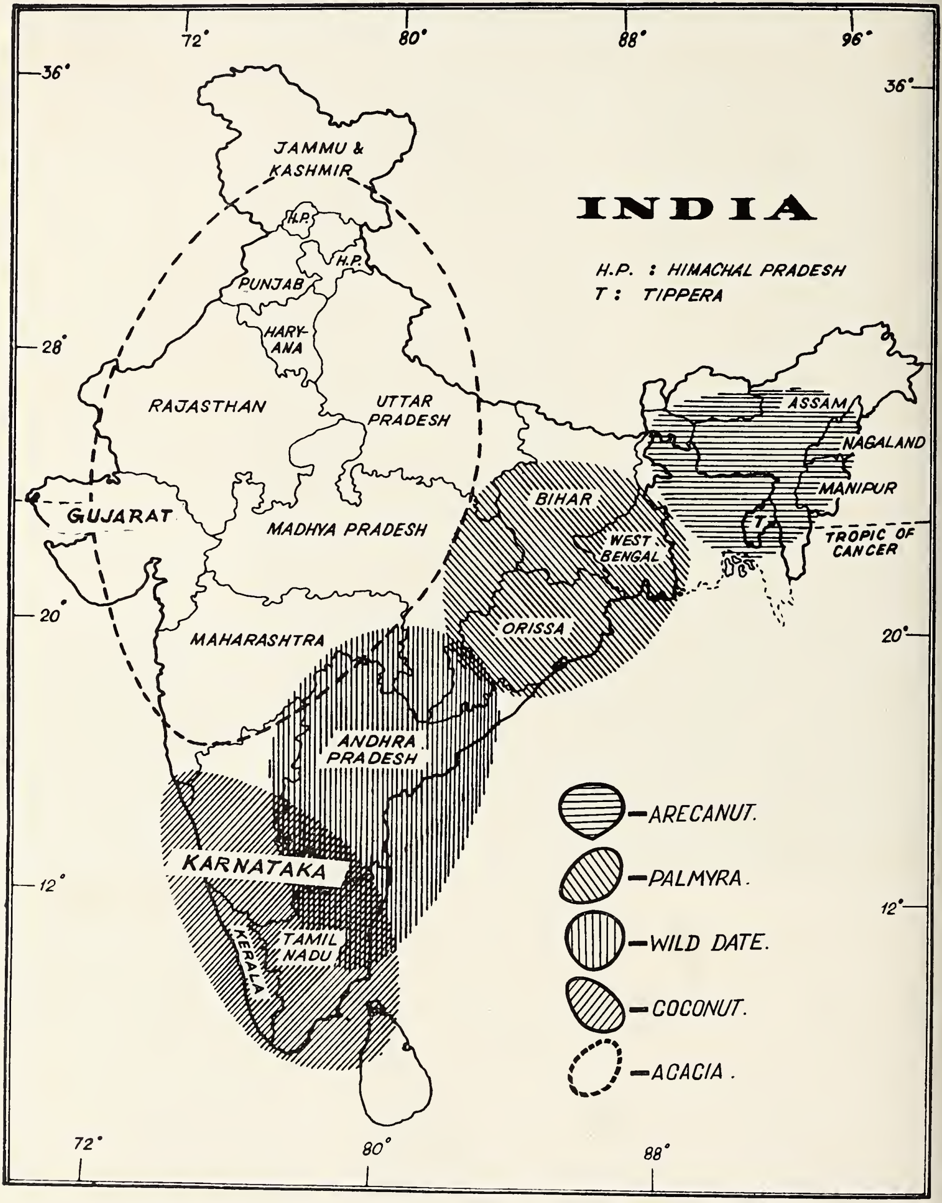
INDIA
H.P. : HIMACHAL PRADESH
T : TIPPERA
72°
80°
88°
96°
36°
28°
20°
12°
JAMMU & KASHMIR
H.P.
H.P.
PUNJAB
HARYANA
RAJASTHAN
UTTAR PRADESH
GUJARAT
MADHYA PRADESH
BIHAR
WEST BENGAL
ASSAM
NAGALAND
MANIPUR
T
TROPIC OF CANCER
ORISSA
MAHARASHTRA
ANDHRA PRADESH
KARNATAKA
TAMIL NADU
KERALA
—ARECANUT.
—PALMYRA.
—WILD DATE.
—COCONUT.
—ACACIA.

Fig. 3. Preferred host trees for founding baya colonies in different regions of India.

spines. Other unprotected trees are also used for nesting, like *Terminalia arjuna* whose trunk is extremely slippery. At other times, the bird builds nests on unarmed trees like margosa (Fig. 2), drumstick and mahua standing in close proximity to human habitations or whose stems are surrounded by a sheet of water. In most of these cases there is a good source of nesting fibre in the vicinity.

The most preferred host tree seems to be *Acacia* sp. With the exception of three states all have colonies on one or more species of *Acacia*. *Acacia arabica* and *A. leucophloea* are the most common species. The prominent and profuse thorns present all around the plant, the numerous slender branches that form a dense crown, and the tree's capacity to withstand waterlogging for long periods keep off most enemies including crawling predators like tree snakes, tree rats and even the curio-hunters. It is striking that even shorter acacias standing in water are preferred over nearby bigger ones of the same species on dry ground. As acacias are devoid of nesting fibre, it may be inferred that the safety of the nest and inmates becomes the foremost consideration in choosing a nest site and takes precedence over availability of nesting fibre or food.

Critical examination of the figures in the Table shows that the baya colonies in different localities seem to prefer different host trees or structures for nesting. For example, in the Assam region, over 84 per cent of the colonies were located on *Areca* palm, and about 60 per cent of the colonies in Andhra Pradesh were on wild date (*Phoenix sylvestris*): see map of India in Fig. 3. In the region of Bihar, Orissa and south-west Bengal (presumably Bangladesh also), palmyra (*Borassus flabellifer*) is the preferred host tree. Similarly, in southern India comprising the states of Kerala, Tamil Nadu and Karnataka, over 60 per cent of the colonies were established on the coconut palm. In the remaining states of northwestern India (Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Rajasthan, Haryana, Punjab, Himachal Pradesh, and Jammu & Kashmir), acacias are the most preferred hosts. It is also striking that telegraph lines are popular as sites in Assam.

The choice of host trees by baya may be variously motivated, and unless the vegetation and ecology of the various tracts, and the nature of predators, are studied thoroughly, it may not be possible to understand the whole of a situation. It is not always a tree which provides nesting fibre or one that is most common in a locality that is preferred. However, in Kerala, Karnataka, and Tamil Nadu, coconut, the preferred host, is the most common tree and it yields the nesting fibre. But the reason occurring to me is the fact that in this region, people traditionally do not disturb the baya colonies on coconut as some ' wise men ' in the past had spread the rumour that the yield of coconut would drop suddenly if baya colonies on them were destroyed. Hence, although the palmyra palms armed with serrated leaf-stalks are abundant in these states, coconut is mostly preferred. Since coconut cannot protect from tree snakes that are prevalent in this region, as an adaptation the nests are usually provided with very long entrance tubes to prevent snakes reaching the egg-chamber (Davis 1971b).

In the region comprising Orissa, Bihar and West Bengal (south) where palmyra is the preferred host, coconut, arecanut, wild date and acacias are equally common. Palmyra leaf is incidentally too hard for the baya to collect strands from it and hence nests on palmyra are always woven with fibre from other plants. One would, therefore, expect more colonies on acacias or on wild date than on the palmyra. Further, palmyra is the most common tree in Andhra Pradesh. But in this region, most of the colonies are established on wild date. Anyone travelling through Andhra Pradesh can see for himself how the palmyras are cruelly defoliated, leaving only a couple of the very young leaves. Palmyra leaves are traditionally cut for making various articles such as baskets, hats and mats. Past experience of calamities resulting from cutting of leaves hosting nests must have induced the bird in Andhra Pradesh to select trees other than palmyra for nesting. In the northwestern states of India where acacia has been the most preferred host, wild date, which provides fibre, grows abundantly. But acacias are preferred even though they don't provide the nesting fibre. The rainfall of this region is very low and the monsoon commences from July when the rain-fed crops of millets and maize are grown. Moreover, several species of grasses spread their numerous leaves. Sugarcane (where cultivated) also produces large and abundant leaves during the monsoon. All these graminaceous plants supply the leaf strands for woven nests. Moreover, the acacias are usually small trees surrounded by the millet crops, and carrying the leaf strands cannot be a serious problem. Of the acacias, the bird usually prefers those which are surrounded by water. Another factor which seems favourable with acacia is that the foundation for a nest is more easily attached on its twig than on the leaflets of palms. Thus, in spite of the lack of fibre strands, acacia seems to be the most perfect host tree for a baya colony.

The map of India (Fig. 3) further reveals that along the east coast and in Assam, colonies of baya are mainly founded on palms (coconut, wild date, palmyra and areca). Exceptional baya colonies were also noticed on palms such as *Arenga pinnata*, *Caryota urens*, *Hyphaene thebaica*, *Livistona chinensis*, *Phoenix dactylifera*, *P. fariniera* and *Roystonea regia*. This region receives relatively more rain, which is well distributed. Therefore, rivers, ponds and tanks abound here which sustain green vegetation over a greater part of the year. Most of the palms provide nest-weaving fibre round the year. Such a situation induces the baya to have a prolonged nesting season which usually extends from May to early November. On the other hand, the birds in northwestern India, preferring the acacias for nesting, have a shorter period which extends generally from July to the end of October. The birds in this region must await the monsoon, which commences from July, not only for the supply of insects to feed the young, but also for the nesting fibre which comes mostly from millets and other grasses.

NEST-BUILDING ACTIVITIES OF THE MALE

Nest-building activities in the weaverbirds have been studied by many workers (Ali 1931, Crook 1960b, 1964 ; Collias & Collias, 1962, 1963).

I studied the progress of nest-building in six baya nests of a colony on a palmyra palm located at the northern end of Calcutta by observing them continuously for 12-14 hours daily during April-May from a 5 m high platform (a machan not a hide) erected within 4 m from the host tree. It was flanked to the south 4 m away by a date palm and on the north about 25 m away by a row of five coconut palms. There was a pond on the eastern side. The bamboo platform was due west of the colony from where I could make out clearly whether a bird at a particular time brought a load of coconut fibre, date fibre, a load of mud or nothing at all. After nearly an hour's initial caution, the baya quietly acclimatized and ignored the observer's presence.

Amazingly, a male baya works for twelve to thirteen hours a day during the nesting season, not breaking for more than 30 minutes at a time for foraging, preening, resting or pursuing a female in courtship. If the male has already completed a nest, the site for the new nest is often chosen very close to it. Otherwise, any suitable and strong palm leaflet is selected and one or two small slots or wedges made to fix or tie the initial fibres. In a dicotyledonous plant like *Acacia*, usually the tip of a horizontal thin shoot forms the nesting site. Making the foundation is the most difficult job, which is done by long sugarcane or coconut fibres where available. On the first day, for the construction of the wad and suspension of one of the nests studied, the male brought fibre at the rate of four loads per hour. The initial ring was also formed in the course of the first day itself. From the graph (Fig. 4) it is seen that the frequency of bringing fibre increased steadily when once the nest suspension was completed. On the second day he brought 8 loads per hour, which frequency increased to 26 on the fifth day when the nest was half complete with two distinct openings at the bottom intercepted by a narrow bridge. The latter served as a platform for the bird to perch and rest or work. This stage is usually called the 'helmet' stage and thus it is the home of a 'bachelor' who is yet to acquire a mate. Then, on the fifth day, almost once every two minutes he was able to bring and weave a load of fibre. In addition, the bird visited the nest without any fibre several times. Such barren visits were at the maximum when he was engaged in luring a female. It is known that a male baya brings loads of mud or cattle-dung and deposits them on the inner walls of the egg-chamber (Davis 1972). From the second day of starting a nest such pasty materials are brought, and the frequency of such loads per nest varies with regions. The graph in Fig. 4 does not include the visits with mud or dung which per day was not more than six.

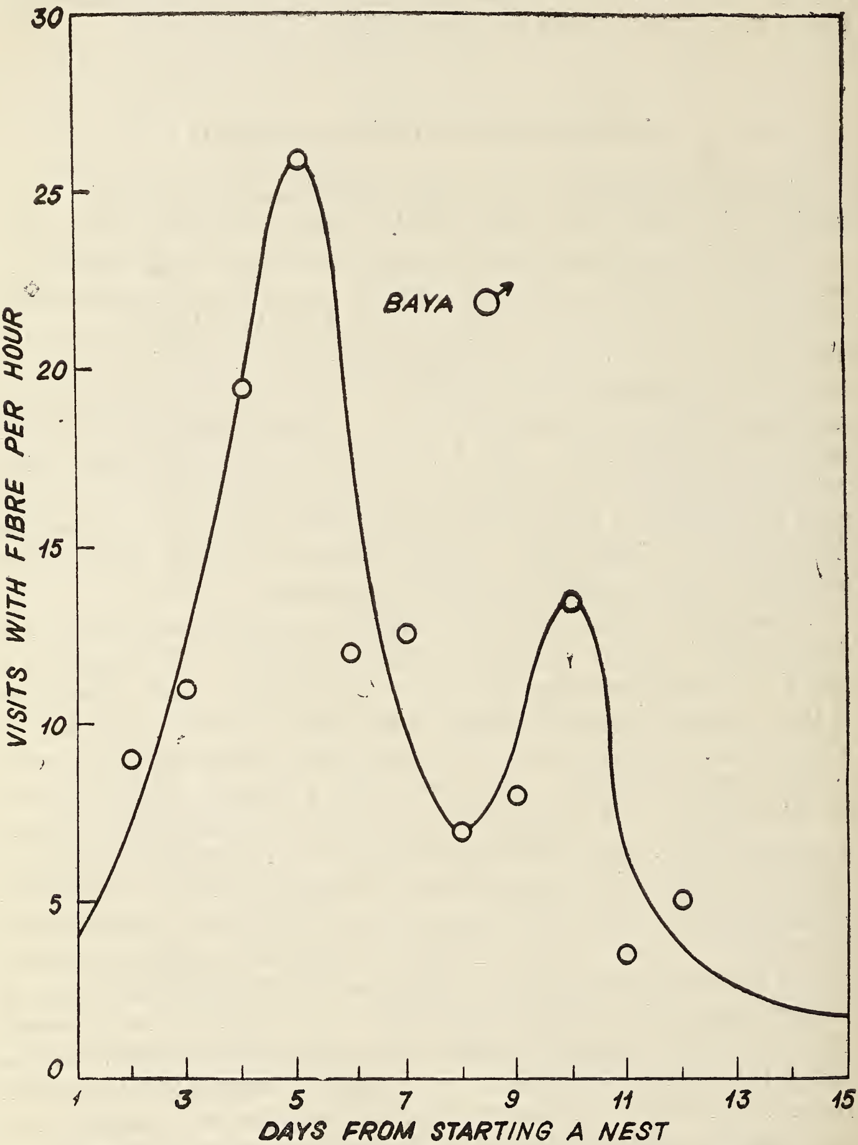

FIG. 4. Graph showing the frequency of male baya's visits to the nest with building material.

From the sixth day there was a decline in the nest-weaving activity which indicates an important behavioural change. The two openings of the nest continue to remain until its owner is able to secure a mate, for nests are completed only if the hens approve them. At this time the female baya in her egg-laying stage starts visiting the palm in search of a nest and a mate. When a female is sighted from afar, the males of the colony are beside themselves with excitement, and there is a big commotion with hectic flights around the trees. Each male in his nuptial golden plumage displays himself by perching on his nest and fluttering his wings and lifting the nest towards the female. This display is accompanied by a deafening chorus of bird-song and violent flutterings of wings. By the manipulation of the tail, he swings to and fro, often hanging head downward. At the climax, he sometimes reaches the approaching female and escorts her to his nest. The hen, apparently calm and sedate amidst the amorous daylight serenades and chattering advances of the cock, alights on the narrow bridge of the nest. She tests the strength of the nest by poking her beak into the wall and pulling out some fibre as if performing a ritualized test of building standards. During these tense moments, the male watches her hopefully, often chasing off other males who may approach. But after some time the female gets out of the nest and tries another vacant home. She inspects all nests available for occupation likewise, thereby apparently assessing the weaving competence of the males. It is strange that though she is unable to weave a single fibre, she seems competent to judge and select the best nest. The same or the following day she repeats her visit to the nest of her choice, and more frequently thereafter, indicating her willingness to accept the architect of that nest as her mate. The first mating of the pair, usually taking place while the hen is perched on the bridge of the nest, revives the nest-building activity of the cock. During the period when the male entices a hen, he makes several visits to the nest without any fibre. On some days such empty visits may equal the number of loads of fibre brought.

On the eighth day, a cup-like egg-chamber was actively built by closing one of the openings and this activity is shown by the second node in Fig. 4. The four-day period (from the fifth day) represents the cock's intense activities to lure a hen, and such a period is prolonged in the case of the less efficient males not capable of weaving ideal nests. From the second opening, a tubular entrance is woven downwards. The female collects fine feathers or cotton wool and prepares a soft lining in the egg-chamber and lays a clutch of 2-4 eggs. By the end of this period when the nest with its tubular entrance is completed, the cock leaves both nest and hen, and his interest shifts to building another nest for another prospective mate. At a later stage the male makes occasional visits to the original nest to feed the young. Such visits are not shown in the graph.

NEST VISITS OF THE FEMALE

After the short conjugal life, the hen undertakes the strenuous job of hatching the eggs and feeding the young almost single-handed. The incubation period is 12 to 14 days. The female does not sit on the eggs continuously for more than two hours, but gets out and perches on the helmet part of the nest preening and relaxing, or flies away to forage. The frequent interruptions in the brooding seem as if to keep the eggs from overheating. In the Cape Weaver Bird (*Hyphantornis capensis olivaceus*) incubation of the eggs is mostly at night, the warmth from the sun presumably being sufficient during the day. Jayakar & Spurway (1965) recorded another interesting phenomenon with the yellow-wattled lapwing. During the hotter parts of the day, the parent pair cooled the eggs of their clutch by wetting their breasts and bellies in standing water immediately before walking on to the nest.

The day the eggs hatch, the mother baya is visibly excited and she goes in and out of the nest frequently. The broken shells of the eggs are dropped directly beneath the nest. Perhaps one reason for the baya's preference to nest on locations overhanging water is to conceal from enemies the droppings and shells. Now she spends more time nursing and brooding the young, and flies out only during the feeding time in search of food. The first day the hen under observation brought food at the rate of about 3·5 trips per hour and remained active for over twelve hours in the day. On the second day, the frequency increased to 6 per hour, and thereafter as the appetite of the nestlings increased, the mother brought more food at frequent intervals (Fig. 5). On the ninth day she brought food at the rate of 17 times an hour, being the maximum for feeding three nestlings. The frequency of food-visits gradually decreased either due to the decreasing appetite, or possibly the mother brought bigger loads of food. On the seventeenth day, the fledgelings left the nest. In some nests, fledgelings left on the sixteenth day. Very rarely the father brought food, but his visits appeared to be motivated by curiosity rather than responsibility. Ambedkar (1964) reported a fairly high degree of active participation of the cock in feeding the young.

A pair of crows (*Corvus splendens*) nesting on a palmyra palm opposite my home at Calcutta were observed for a month. The graph (Fig. 5) shows that the crow-parents together did not make half the number of food visits as the single baya mother. The baya feeds the young with animal food although the adults mainly eat grain. The crows of this nest were found to feed the young with discarded food and grain from nearby houses. As the baya brings usually one insect or a worm each time, it can satiate only a single nestling in one visit. On the contrary, the crow is able to feed more than one nestling in each visit as the food it carries is easy to share.

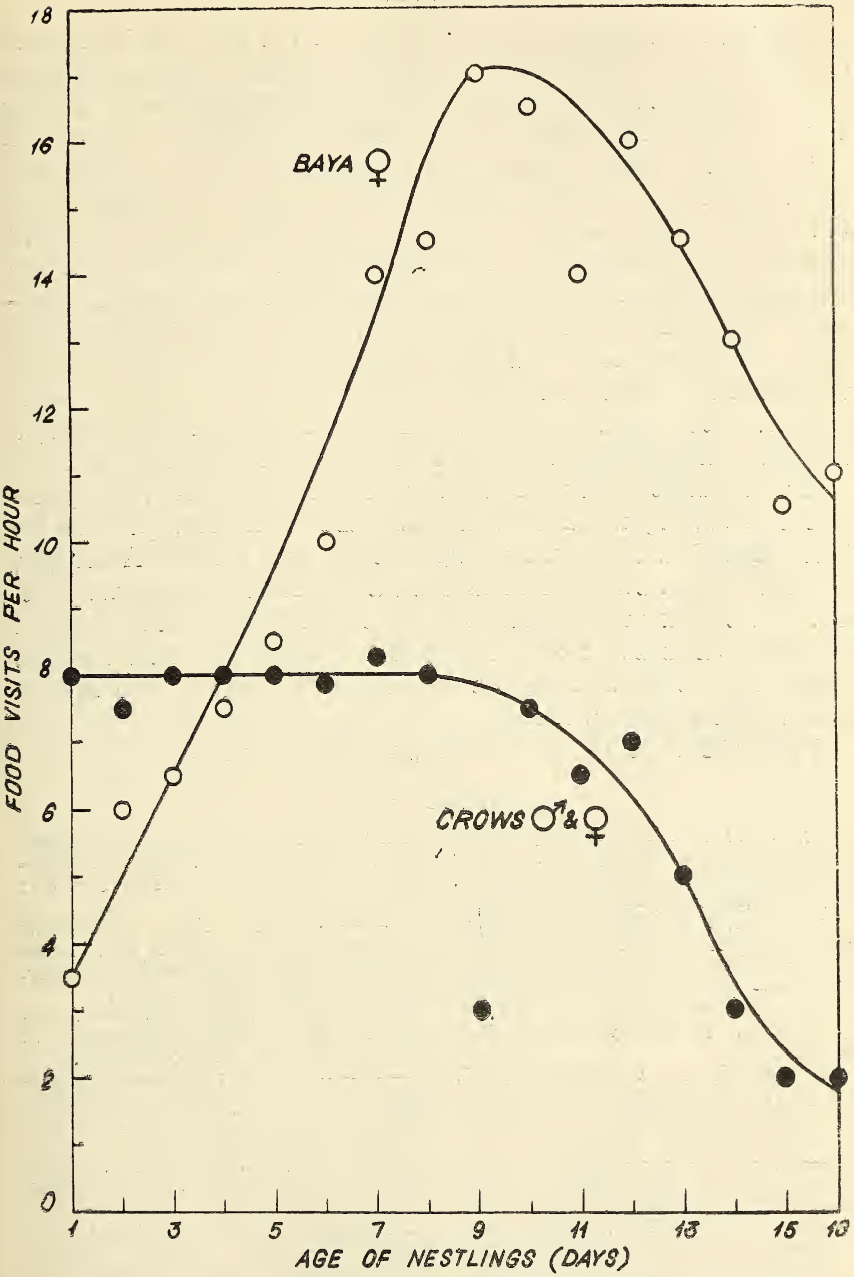

FIG. 5. Graphs showing food visits of the female baya ; and food visits of a pair of crows nursing 3 young.

SUMMARY

The baya weaverbird *Ploceus philippinus* (L.) in India has been found to colonize a surprising variety of plants, as well as structures like house eaves, telegraph and power lines and the sides of irrigation wells. During a survey of the Indian states, 1485 colonies were recorded. 68 per cent of the colonies were located on plants beset with thorns, prickles and similar defensive structures, besides those on electric or telegraph lines and inside irrigation wells which are adequately protected against predators. The most preferred tree is *Acacia* sp. The choice of a host tree seems to be variously motivated subject to local ecological conditions. Thus, baya colonies, depending on locality, prefer different host plants for nesting and often ignore apparently ideal trees which are also available. From data collected it may be inferred that the safety of the nest and inmates is the foremost consideration in choosing a nest site, taking precedence over availability of nesting fibre or food.

By watching a colony continuously for 12-14 hours daily, the specialized nest-building activities of the male, and the number of visits the female made feeding the young single-handed, were studied. Amazingly, the bayas remain active for 12-13 hours a day during the breeding season. On a peak day, the male brought a load of fibres and completed weaving them in about two minutes and this pace was maintained the whole day. The female brought a maximum of 17 loads of food an hour to feed the nine-day-old nestlings.

I thank Mr S. K. De, artist, for making the drawings.

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On the biology of the Olivaceous Leaf Warbler of the Tian-Shan Mountain[1]

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(*With three plates*)

The Olivaceous Leaf Warbler (*Phylloscopus griseolus* Blyth) is a typical representative of the avian fauna of the mountainous regions of Middle and Central Asia and partly in south-western Siberia, from Upper India on the south to the sources of the Ob on the north. It inhabits the Western Himalayas, the northern border of the Tibet upland and the Kuen-Lun Mts approximately up to 91°E., the mountain ranges in Afghanistan to the north of Ziarat (in Baluchistan), the Hindukush, Western Kashgaria, Pamir, Kuhitang and Tian-Shan Mts, the Dzungarskiy Alatau and Tarbagatai ridges, the central and north-western parts of Altai, the Khangai Altai and Gobi Altai approximately up to the 85°E. It nests sporadically in the eastern part of the Kazakh plateau. The Olivaceous Leaf Warbler winters in Pakistan and India as far as Hyderabad in the south.

The biology of this species is still very little known. The data on the way of life of this warbler in diverse ranges of the Tian-Shan mountainous country available in the literature (Zarudniy & Koreev 1906; Shnitnikov 1949; Korelov 1956a, 1956b; Stepanian 1959; Yanushevich *et al.* 1960) are rather scanty and fragmentary. The main materials for this paper were collected in the Bolshoye Almatinskoye canyon of the Zailiyskiy Alatau range (in the northern Tian-Shan, near Alma-Ata) in 1964-5 by I. A. Dolgushin, E. I. Gavrilov, E. F. Rodionov and M. A. Kuzmina, in 1967 and 1969 by E. F. Rodionov, and 1971-2 by A. F. Kovshar. The observations of A. F. Kovshar in the Talasskiy Alatau ridge (in the western Tian-Shan) in 1960-66 and the data from literature on other ridges of the Tian-Shan were also used.

Unlike other representatives of the genus *Phylloscopus*, the Olivaceous Leaf Warbler is not a forest bird and during the nest period avoids forests and soft grassy slopes, preferring rocky slopes with thinly growing

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[1] Received October 1972.

shrubs. In the Tian-Shan it usually nests above the upper limit of fir-groves but it can descend to the forested zone along stone screes : in the Zailiyskiy Alatau ridge at least up to 2300 m, and in the Terskei Alatau ridge up to 1900 m (Kovshar 1972a). In the Terskei Alatau the vertical distribution of this warbler is rather peculiar. In the eastern portion of the ridge it inhabits the Alpine and Subalpine zones up to 3700-3800 m, is absent in the forest zone and reappears on the slopes of the foothills facing the Issykkul Lake depression ; in its western part, where the tree zone is not continuous, the Olivaceous Leaf Warbler probably nests everywhere from the foothills up to the Alpine grasslands (Stepanian 1959).

The favourite places of nesting of the Olivaceous Leaf Warbler in the Bolshoye Almatinskoye canyon are the stony taluses and deposits with large boulders and some patches of creeping juniper (*Juniperus turcestanica*) or stunted little bushes of *Lonicera* sp., *Spiraea*, *Atraphaxis*, *Cotoneaster*. Under such conditions it also nests on the edges of spruce-groves, but does not enter the depths of the forest. Only once, in June 1971, a couple of birds made an unsuccessful attempt to build their nest on a fir-tree in a relatively thick forest (2315 m).

The numbers of the Olivaceous Leaf Warblers in the Tian-Shan are low. It is rare in the Terskei Alatau ridge (Stepanian 1959), not numerous in the Talasskiy Alatau (Kovshar 1966) and on the northern slopes of the Kungei Alatau, but rather frequent in the Zailiyskiy Alatau.

In spring the warblers appear in their nesting places by the last ten days of April. In the Bolshoye Almatinskoye canyon in 1965 the first was seen on 29 April, and in 1972 on 23 April. In the neighbouring Kaskelen canyon the arrival was registered on 28 April 1954. To the southern slopes of the Talasskiy Alatau in 1954 the warblers arrived on 21 April, to the western part of the range in 1958 on 27 April, to the northern slopes in 1966 on 27 April and in 1965 on 28 April. In the Issykkul Lake area and to the south of it they appear a little earlier. For example, in Naryn (Central Tian-Shan) in 1909 they arrived on 15 April, on the southern slopes of the Kungei Alatau ridge a male was taken on 15 April 1952 and in the Terskei Alatau on 26 April 1956 (Yanushevich *et al.* 1960). A very early arrival was registered in the Terskei Alatau ridge in 1961 : two males were observed there on 25 and 26 March, but after that they evidently did not appear till 12 April (Shukurov 1968).

In the beginning the warblers are rather secretive and only their characteristic call, strikingly resembling the sound of water drops dripping on to a wet stone, betrays them. But in a few days the males begin singing : in 1972 the first song was heard on 28 April and in 1965 on 3 May, i.e. 5 and 4 days after the arrival. The song consists of 3-9, usually 4-5 notes of the same pitch closely following one after another. They can be represented as *tivtivtivtivtiv*, *twitwitwitwitwi*, *kwikwikwikwikwi*,

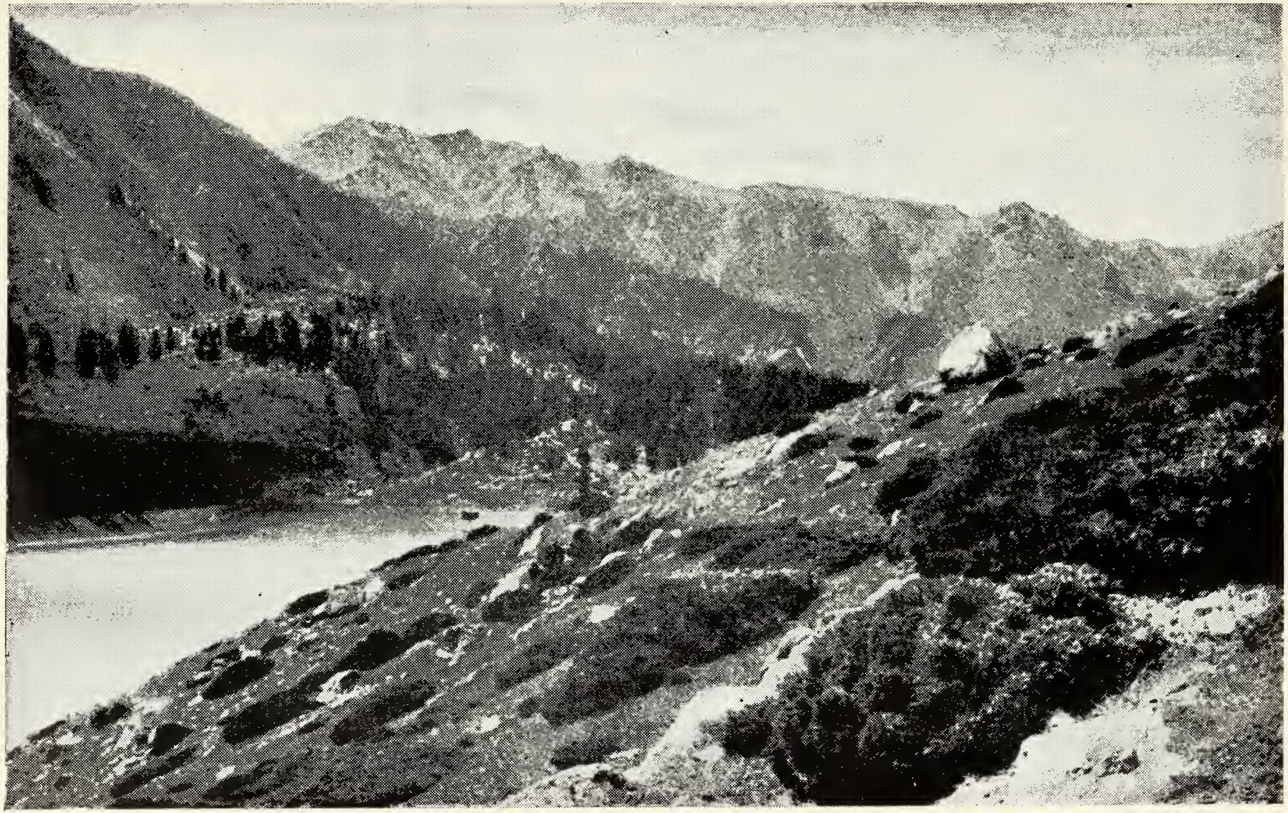

Fig. 1. The surroundings of the Bolshoye Almatinskoye lake.

Figs. 2 & 3. Nesting places of the Olivaceous Leaf Warbler.

wiwiwiwiwi or *ktitititititi*, all in the same key. Sometimes the song is preceded by a call resembling the smacking of lips. The birds sing more frequently perched on stones, but sometimes they sing in bushes and even in the crowns of fir-trees.

In the beginning the birds sing very rarely, usually single songs with great pauses between them. In early May sometimes 30-40 calls may be heard in succession and in the middle of the month it is possible to count 50 calls in 15 minutes, emitted by one bird. The peak of the vocal activity falls in late May—before the beginning of nidification. On 24 May 1971 at 8.00 a.m. a male sang 102 songs in 15 minutes. During this period the males sing not only when moving or collecting food, but also sitting in one place. At the moment of highest excitement (when the female is by him) the male's wings often quiver and the tail is raised upward almost like a wren's.

During the building of the nest the males sing intermittently, emitting several songs at a time and accompanying the female who is flying in search of materials. They also sing briefly but often in the breeding period, when they come flying to the nest and especially before flying off for a new portion of insects. After the young begin to fly the singing of the Olivaceous Leaf Warbler not only does not stop, but even increases. For example, on 18 July 1971 a male feeding nestlings that had begun to fly sang 144 times from 8.00 to 9.00 a.m., and 109 times during the next hour. Throughout the second half of July, when the Olivaceous Leaf Warblers fed their fledgelings, their singing can be often heard at any hour of the day, from 5.50 a.m. till 19.40 p.m. In August they sing more rarely but regularly till the end of the month.

The last song in the Bolshoye Almatinskoye canyon was heard on the 7th of September, 1972.

The birds nest in separate pairs settling at a considerable distance from one another, which in the Bolshoye Almatinskoye canyon averages 150 m. Their attitude to other species is indifferent; one Olivaceous Leaf Warbler's nest was found at a distance of only 10 m from the nest of a Yellowbrowed Warbler.

The pairs form apparently not later than the first half of May, as till this time only single birds are seen, in most cases singing males. The earliest sighting of a pair was on 16 May, 1965. However, the singing males obstinately prefer some places, the future nesting territories, even before pair formation. The birds while nesting show a preference for well warmed southern and eastern slopes. In the Bolshoye Almatinskoye canyon 13 nests (86·6%) out of 15 were on the eastern, south-eastern and southern slopes and only 2 (13·4%) on the northern ones. In the Terskei Alatau ridge 8 cases of nesting on the slopes facing the southern compass points have been observed and not a single one on the northern (Kovshar 1966).

After the middle of May the Olivaceous Leaf Warblers begin to build their nests which they arrange in the bushes or on grass stems not very high above the ground. In most cases nests are built on the low bushes of creeping juniper. Eleven nests from 23 found in the Bolshoye Almatinskoye canyon were built on juniper, the rest were found as follows : 6 on low stunted leaf-bearing shrubs with not dense foliage (honeysuckle 3, sweetbriar 2, rowan tree 1) and 5 on grass stems, mostly cereals growing near stones or under the crowns of bushes. The height of the nests above the ground may be 5-50, usually only 5–15 cm (50% of the nests), and one nest was situated so that it almost touched the earth. Only once the birds made an attempt to build their nest on the lower branches of a 25 m fir-tree at a height of 2 m from the ground but they abandoned it half-made.

In the Terskei Alatau ridge a nest was found in a bush of creeping juniper (Stepanian 1959), and in the Talasskiy Alatau, besides creeping juniper, meadowsweet, wormwood (2 nests) and astragalus, two nests were constructed on the lower branches of 15 m-old juniper trees (*Juniperus zeravshanica*) at a distance of 40 cm from the ground.

The nest is a closed elliptical construction with the entrance on one side. It is woven from dry grass stems and narrow strips of bast and the inside covered with down and feathers. When the nest is made so warm it may seem that the orientation of the entrance does not play an important rôle, but according to data collected in the Zailiyskiy Alatau ridge the Olivaceous Leaf Warblers prefer the southern and eastern cardinal points. Thus, out of 19 nests the entrances of 6 were directed to the east, 4 to the south, 2 each to the south-east, south-west, west and north-east, and one to the north-west. The sizes of 7 nests from the Zailiyskiy Alatau were : length (along the axial line passing through the entrance) 90-170 (aver. 139) mm, width 115-190 (aver. 118) mm, height 85-150 (aver. 126) mm, the diameter of the chute 50-70 mm, its depth 20-45 mm. The height of the chamber of one nest was 73 mm. The entrance has the form of a horizontal oval, its width equals 40-46 (aver. 43) mm, its height 28-40 (aver. 34) mm. About the same sizes are reported for nests from central and western Tian-Shan (Stepanian 1959 ; Kovshar 1966).

The nest is built by the female,[1] and the male in the meanwhile remains nearby, sings, sometimes accompanies the female and in one case obviously tried to take away from her the building material which she was carrying to the nest. The female carries bast from bushes growing at a distance of 20 to 60 m, flying repeatedly to the same selected shrub (mostly honeysuckle). Jumping from one branch to another, she pulls off with force narrow strips of bast, fluttering with her wings, setting her feet against the branch and sometimes even trying to take flight without having completely torn off the strip. After having gathered in her beak some ten strips, she flies swiftly and without stopping towards the nest, but does not enter it at once ; instead she sits on some branch not far distant and looks around, emitting a low 'smacking' sound. Depositing the material in the nest takes only half a minute. A little more time is spent in the gathering of bast and grass, but sometimes the female returns to the nest with the material in one or two minutes. To one of the nests the female during an hour, from 11.25 hrs. to 12.25 hrs., brought bast of honeysuckle 9 times; to another in the period of one hour and a half (from 10.30 till 12 noon) 17 times. The bird brings down and feathers much more seldom, as it has to fly 200–300 m in search of them. Thus, during 7 hours of observation (from 6 to 13 hours), the female arrived at the nest only thrice, at 9, 12 and 13 hours. Building is carried on chiefly in the first half of the day, especially in the forenoon (in 7 nests it was observed between 10.00 and 12.00 and only in one at 7.30), rarely in the evening : females with material in their bills were seen only 3 times, at 16.00, 19.00 and 20.00.

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[1] Indications that the male participates in the nest-building (Abdusaliamov 1964) are not confirmed by our observations, made over many years.

The building of the nest takes 4-10 days and sometimes more. As a rule if the construction was begun earlier it takes more time than with the late ones. Thus, one nest was one-third built on 22 May and finished only on 31 May ; another one on 22 May had already an elliptical form, but was finished only on 29 May. Yet a nest begun on 29 May was finished by 5 June, and another begun on 19 June finished on 23 June.

The female begins laying eggs 2-6 days after finishing the nest, on the average (8 birds counted) 4½ days after. The shortest interval is when the nest has been built very late. Eggs are laid every day in the morning. In a full clutch there can be 4–6, as a rule 5 eggs. In the Zailiyskiy Alatau ridge in four nests were 4 eggs, in thirteen 5 and in one 6 eggs. In two nests only 2 and 3 eggs were found, but these layings were seemingly not completed. In the Terskei Alatau a nest was found with 5 nestlings (Stepanian 1959) and in the Talasskiy Alatau in three nests there were 5 and in one 6 eggs (Kovshar 1966). The incubation begins after laying the last egg and lasts 14-17 days ; in the 5 cases known to us the young were hatched 14, 15, 15, 15 and 17 days after the laying of the last egg.

The young hatch in a period of 24 hours and in size have almost no difference at all. The sparse greyish down grows in bundles over the supraocular, occipital and humeral parts of the body. The skin is yellow. The ends of the mouth are whitish, its inner surface is yellow and the tongue without spots. The eyes and the acoustic duct are closed.

The young are fed by both parents. The first days the female warms them for most of the time and the food is carried by the male, but when they are already a week old the young receive food more or less equally from both parents. Thus, in one nest with 5 two-day-old nestlings, the male brought food 64 times during the day (from 5.05 till 20.10). The female who sat warming the young left the nest 19 times during the day each time being absent for 2-11, mostly for 5-8, minutes (only once, at noon, she was absent for 25 minutes), but she only brought food 7 times and the remaining 12 flights she apparently used in order to feed herself. Six days later the parents brought to this nest 120 portions of food, of which 58 were brought by the male and 62 by the female, the latter leaving the nest each time after the feeding. In another nest four 8-day-old young were brought 174 portions of food ; it was carried by both parents, but the female sat 4 times on the nest for 15, 8, 12 and 6 minutes, mainly during rain. Five days later the warblers brought to these young 175 portions of food (86 by the male and 89 by the female). It seems that the intensity of feeding noticeably increases only during the first week of life of the young and in the following 7 days it remains constant.

Each portion of food consists, as a rule, of several insects, sometimes of a big caterpillar or butterfly. Accordingly it is distributed between the young or given to one of them. In one of the nests the male more often fed one of the young, rarely two of them, but the female usually divided the food between two or three of them, the bulk of the portion of food being given to one of the nestlings. The flights for food usually are not far, a distance of 70-80 m, but sometimes the warblers may fly away for 100-150 m.-Insects are usually gathered and caught on the surface of stones and in the cracks between them, often in the grass and branches of low leaf-bearing shrubs. They collect food much more rarely in the crowns of spruce-trees, picking the insects and their larvae among the needles ; in one case we observed the male who, fluttering his wings and hanging in the air for several seconds in front of a fir branch, swiftly and deftly picked something from among the needles ; this method was used by him several times. The ability of the Olivaceous Leaf Warblers to move with certainty on vertical planes allows them to seek for food even in an unusual environment. We had the opportunity of observing how a warbler during half an hour fed on wooden electro-transmission poles, searching one pole after another for food. Sitting at the foot of the pole, the bird quickly examined the cracks in the wood and the fissures between the wood and the iron rail container, then it began to move up the pole, taking from the cracks the insects hidden there, mainly flies. During the ascent she turned freely in all directions, even head down, but moved only upwards.

The young are fed chiefly insects, rarely spiders. In 21 samples of food, taken in two nests with the help of ligatures round the neck (Malchevsky & Kadochnikov 1953), there were 10 butterflies, 7 caterpillars, 6 flies, 2 collembola, 1 grasshopper and 5 spiders. Visual observation near the nests gave 102 (37%) cases of butterflies and 132 (48%) of caterpillars. The remaining 15% consisted of flies (23 cases), mosquitoes (7), bot-flies (1), collembola, grasshoppers (2) and spiders (7). There is practically no difference between the food carried by the male and the female. Both parents equally share the task of keeping the nest clean and take away the faecal capsules with regularity.

The young grow rather quickly and when 11 days' old are already so active that they can easily leave the nest if frightened. Sometimes this may happen without any obvious cause. Thus, in one nest on the twelfth day two young scrambled out of the nest and hid beneath it. When we put them on their former place they remained there, but two days later without obvious reasons they again one after another (at 9.41 and 10.19) left the nest and sat on a stone within 2 m of it. Only after 6 hours of hunger (their parents fed only those sitting in the nest) both young one after another independently returned to the nest. Normally the flights of the young take place in the morning (in one nest at 9.00, in another at 10.00), 15-17 days after they hatched. In three instances the young left the nest after 15 days, in one after 16 and in one after 17.[1]

The young that have left the nest hide not far from it in the shadow of bushes or overhanging stones and keep very still—at feeding time they can be located by the song of the male or the low call of the female. After a week the young fly rather well but keep close to the nest; we met two of them on the 7th day at a distance of only 3 and 10 m. They apparently return to the surroundings of the nest periodically. Thus, on the above-cited day, the male took two young away with him to 50-70 m. In both cases he behaved identically: having flown without food to the bush under which the young was hidden he began to sing and when the latter climbed into the bush asking for food, he suddenly flew away for 10 m, then again and again, thus leading the young bird in the desired direction. Next morning, the young were again hidden near the nest. This bird kept in the neighbourhood of the nest for 15 days, from the 12th till the 27th of July, and all this time the male went on singing and feeding the young that could already fly.

The calendar period of breeding of the Olivaceous Leaf Warbler is everywhere rather compressed, as can be seen in the Table.

In the Zailiyskiy Alatau ridge at the altitude of 2370-2700 m the Olivaceous Leaf Warblers begin to lay eggs chiefly during the first 20 days of June. The earliest layings here were begun on 4 June, 1964, and on 4 June, 1971, the latest on 28 June, 1969. It should be noted that late layings were observed only in the years 1960 and 1969, characterized by their cold and delayed spring. For the Alpine zone of this ridge there is only one observation as yet: on 29 July, 1965, at the altitude of 3000 m a brood of flying young was met; which means that this pair began laying eggs in early June, i.e. at the same period they did it at 2370-2700 m.

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[1] In this nest the hatching also took 17 days, i.e. more than in the other cases.

TABLE

DATES OF THE BEGINNING OF EGG-LAYING BY THE OLIVACEOUS LEAF WARBLER IN THE TIAN-SHAN MOUNTAINS

Ridges	Number of nests where the laying has begun					Sources of data
	May	June			July	
	3	1	2	3	1	
Dzhungarskiy	1*	1+1*			1	Zarudniy & Koreev, 1906; Shnitnikov, 1949; Kovshar 1972a.
Ketmen			1*			Korelov, 1956b
Zailiyskiy		11	9	2		Data of the authors
Terskei	1	1				Stepanian, 1959
Atbashi				1		Yanushevich *et al.*, 1960
Kirgizskiy		1*				Kovshar, 1972a
Talasskiy	1	1+2*	2			Korelov, 1956a; Kovshar, 1966
Karzhantau	2	1				Kovshar, 1966
Total	5	19	12	3	1	

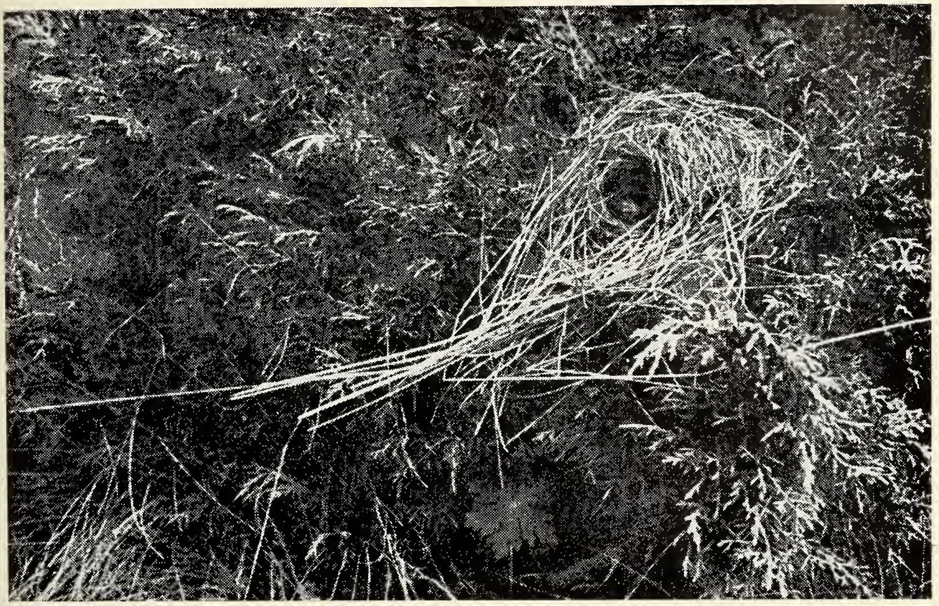
* Data established by observation of broods with incipient flight. The months are divided into 10-day periods, 1 = 1st-10th, etc.

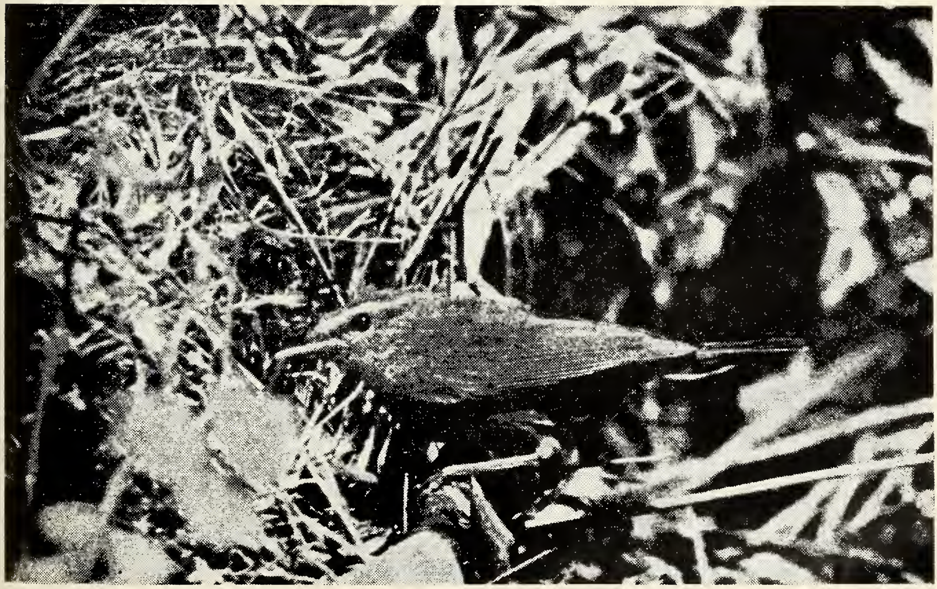
In the Western Tian-Shan (Talasskiy Alatau ridge, 2000 m; Karzhantau ridge, 2500 m) the dates of nesting of the Olivaceous Leaf Warblers are somewhat earlier; some pairs begin laying eggs in the middle of May. At this same date they begin laying in the foothills of the Terskei Alatau ridge (Stepanian 1959).

On the whole in the Tian-Shan mountains the Olivaceous Leaf Warblers nest from the middle of May till the middle or second half of June. In May they build their nests, till the 20th of June the bulk of the population lay eggs, in the second half of July the nestlings leave their nests and at least for two weeks continue to be nursed by their parents. Thus, the nesting period lasts about two months. It is natural that because of so delayed a cycle and rather late nesting these birds can raise nestlings in the Tian-Shan only once in summer.

About the same date this warbler nests somewhat to the south, in the Pamiro-Alai Mountains, where in three observed nests the laying of eggs

Kovshar & Gavrilov: Olivaceous Leaf Warbler





Figs. 4 & 5. Nest on a juniper tree, and Olivaceous Leaf Warbler at the entrance to a nest.

began in the last days of May and first days of June (Ivanov 1969). Therefore the supposition of the above author that the Olivaceous Leaf Warbler has two layings during the summer is doubtful.

There are data on the breeding success only for the Zailiyskiy Alatau. Here 76 eggs were laid in 16 nests and 49 (64·4%) nestlings left them. Unfertilized eggs amounted to 7·1% (in three nests only one, and in one nest two eggs). Five (31%) nests from 16 were destroyed : three by predators (one with eggs and two with nestlings), one nest with a full laying was abandoned by the birds after a thorny plant had grown through it, and in one nest the single young was dead. This last nest was the latest in date (the laying began on 28 June, 1969), only two eggs were laid, one of which proved infertile and the hatched nestling perished the same day. It apparently was a second laying and its fate may serve as a testimony of the poor adaptation of this species to the restoration of lost layings in a late period.

On the whole the success of reproduction of the Olivaceous Leaf Warblers in the Zailiyskiy Alatau ridge is the same as among most passerines inhabiting the upper border of the forest zone of this range (Gavrilov & Rodionov 1965 ; Kovshar 1972b).

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The food of *Collocalia* swiftlets (Aves, Apodidae) at Niah Great Cave in Borneo[1]

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(*With a plate*)

I Borneo cave swiftlets in the Regional context.

II Aerial flight and feeding observations
  i Super-canopy : lateral scatter
  ii Vertical trends
  iii ' Swarming '
  iv Movements through the cave formation.

III Laboratory analyses
  i Stomach contents
  ii The food spectrum
  iii Ants in particular
  iv The total meal
  v Swallowing and fragmentation
  vi Size factors.

IV How much do *C. salangana* and *maxima* differ in food habits?

Appendix : Swarming insects

References

I. BORNEO CAVE SWIFTLETS IN THE REGIONAL CONTEXT

The Great Cave at Niah (113°48′E, 3°47′N) lies 13 miles behind the South China Sea near Miri in northern Sarawak, a state in Malaysian Borneo. It soars to 220 feet high, 800 feet wide at the largest (west)

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[1] Received November 1972.

of five main mouths, the bottom of which is still above the forest canopy below. The 27-acre floor has yielded some of the oldest prehistoric human remains yet for the area (Harrisson 1964a; Ripley 1967 : 168-72 ; Howells 1972 : 13). The geologically not very old Niah (Subis) limestone (Wilford 1964) is honeycombed with chimneys, tunnels, grottos. In this vast labyrinth, a sort of huge gruyère cheese, throughout the equatorial year move and roost some 4,500,000 swiftlets (Apodidae) of three species, though the third and very much less numerous *Collocalia esculenta* only frequents the light sections. Intimately intertwined with the birds are at least half a million bats of seven resident species, six insectivorous (Medway 1958b ; Harrisson 1967). This teeming mass feeds through and/or *over* the permanently green rainforest which inland runs almost unbroken into the sparsely inhabited interior (Harrisson 1959a; Richards 1936).

At dawn (soon after 0600 hours Malaysian Local Time = 2330 GMT) the great part of this bird population pours out, to remain away twelve or more hours on the wing, while dense streams of bats come back the other way. Before dusk (sunset *c.* 1830 LT) the process is reversed. This terrific traffic would be unmanageable were it not that all but one of the bats and both the dark-roosting birds give out constant echo-location signals. *Collocalia* is one of only two bird genera—the other *Steatornis* of central American caves—with this specialization (Griffin 1958 ; Medway 1959 ; Harrisson 1964b). Although this system possibly is *not* sufficiently refined to enable insect-catching in the dark, it can be valuable in extending dusk for late insect swarms and on moonlight nights (cf. Medway 1962 ; T.H.).

The writer began the Sarawak Museum's investigations at Niah in 1954 and has since spent eleven 'seasons' totalling three years, largely living inside the caves (Harrisson 1957 ; 1959b ; 1970). In 1957 we recruited Lord Medway to develop the faunistic side of the project, with rewarding results now well-known (Medway 1958a, etc ; Harrisson & Medway 1962, etc.). The present study is firmly based on that earlier shared experience, plus the felt need to supplement one somewhat neglected aspect of the previous major swiftlet study (Medway 1962, cf. 1968) : the food problem. Indeed, mainly because of the difficulty of identifying tiny insect fragments from out of these delicate little birds and the impossibility of detecting what they take closely on the wing, swiftlet food has everywhere tended to be taken for granted. Even in the second edition of his great THE BIRDS OF BORNEO, B. E. Smythies (1968 : 292-7) conspicuously omits the FOOD section for *Collocalia* species.

Hitherto most of the meagre information for the Oriental Region (as defined by Sálim Ali 1964) has come from the Indian sub-region. This is summarized in Sálim Ali & Dillon Ripley's HANDBOOK (1970, **4**: 27-32), which files a nil report for food of *C. maxima*, there well-named the Black-nest Swiftlet (in Malaysia previously, unsuitably, Low's Swiftlet; cf. Medway 1966; Smythies 1968). Sálim Ali & Ripley suggest it is 'doubtless' as their No. 683, the closely similar *C. brevirostris*, the Himalayan Swiftlet, said to take 'mainly dipterous and hymenopterous insects'. More exact information is given for the closely related Indian Edible-nest Swiftlet, *C. unicolor*. Four stomachs, studied in February, held two forms of mango-hopper (also at Niah, III, ii, below), other Hemiptera-Homoptera, Coleoptera, Odonata, Hymenoptera, Diptera and Trichoptera; no emphasis on ants, no mention of termites (Isoptera).

At Niah we have the interesting situation where two monocolour species co-exist: *C. maxima lowi*, with the 'Black-nest' (edible when cleaned), and *C. salangana natunae*, the Mossy or Thunberg's Swiftlet (cf. Medway 1961), the former more numerous but both mixed up, nesting inside one cave. They are almost indistinguishable in flight, sometimes difficult even in hand. The only fairly sure differences are over 129 mm wing and more feathered tarsus for *maxima*; wing 119-129 mm, and little or no tarsus feathering on *salangana*. Each species normally nests once a year on numerous but separate patches of wall; *maxima* lays one egg, *salangana* two. Both have protracted breeding cycles, minimum 5 months and up to 7 for *maxima*, peaking broadly between November and March.

From 1947 I was responsible for controlling and conserving swiftlets in this and other caves, including 'harvesting' edible *maxima* nests. Despite extensive exploitation, the Niah population has not decreased—as will be seen in what follows, it may well be near saturation (cf. Medway 1957; Gibb & Harrisson 1959; Harrisson 1964b).

II. Aerial flight and feeding observations

(i) *Super-canopy: lateral scatter*

First, where do Niah's millions feed? Although all Borneo observers have agreed that the dark-nesting swiftlets only casually feed over clearings and inhabited areas, never *under* tree-cover, little more was known. This observer spent nearly 350 hours during 1962-72, mainly in helicopters, establishing an absolute dominance of swifts (5 species) and especially swiftlets (3) as regular super-canopy operators. No other birds except a few Hemiprocnidae were normally feeding at this level, though some eagles hunt downward *into* the forest. Nineteen others were seen in local or migratory flight, only hornbills regularly.

TABLE 1

BIRDS SEEN ABOVE THE BORNEO FOREST CANOPY

(compiled from Harrisson 1963 ; 1966 ; and 1972 unpublished)

Family		No. of species identified	No. of separate sighting incidents	Incidents 1000 ft.+ above canopy	Remarks
Ciconiidae	Storks	1	2	0	
Accipitridae	Hawks & Eagles	13	56	11	Mostly *Spilornis* 2500′
Columbidae	Pigeons	3	13	0	
Apodidae	(*a*) *Collocalia* spp.	3*	2200+	*c.* 50	?*maxima* occ. over 2000′
	(*b*) other true swifts	1	14	2	*Chaetura gigantea*
Hemiprocnidae	Tree Swifts	1†	12	0	—
Coraciidae	Rollers	1	7	0	—
Bucerotidae	Hornbills	6	*c.* 260	1	*Aceros undulatus*
Picidae	Woodpeckers	1	1	0	—
Passerines	(all families)	7	10	1	*Gracula religiosa*
	Total	37	2200+375	50+15	

* *C. salangana* and *maxima* plus *C. vestita* in the Baram basin—not at Niah (Smythies 1968).

† *H. longipennis*, which *mainly* feeds over secondary jungle and clearings.

Lateral spread of super-canopy swiftlets proved erratic. Probable Niah birds were seen far inland, but there is no way of being certain of source at any distance. Sustained helicopter sorties to clarify this aspect in the vicinity of the caves and over the coastal plain during August-December were not fully successful. Co-ordinated with ground watch along the river and one road line (since 1965) on some days, especially if fine, at *any* season, the great mass of birds is not visible within 10-25 miles of the limestone massif. On 20-21 December, as an extreme example, 4 hours' intensive flying mostly north and west of Niah produced only one swiftlet ; simultaneous ground records showed the cave nearly empty of birds at the same times (II, iv, below).

Medway (1962 : 229) had ' never seen *maxima* or *salangana* more than 15 miles from the cave '. But there was then no good way to observe beyond that distance and limited facilities for seeing over the canopy anywhere. On that basis, his own figure (same sentence) of ' at least four million resident adults ' would mean a super-canopy all-day density of 6,000 birds per square mile, even ignoring that the immediate radial land is heavily deforested or cultivated (rice, pepper) and thus only suitable for *C. esculenta* foraging.

Both *salangana* and *maxima* have been timed flying at 25-30 m.p.h. Most are usually away at least 11 hours a day. 50-75 miles inland will take them over huge tracts of virgin jungle, still incompletely explored on the ground (Harrisson 1959a ; Richards 1936), widely without other limestone to support ' competing ' cave populations (cf. maps in Wilford 1964 ; list in Smythies 1968 : 71). Otherwise, surely, the vast Niah insectivorous population—birds and bats—might be insupportable through the year, including long wet periods which flood the forest floor in the immediate vicinity ?

(ii) *Vertical trends*

About 2% of swiftlets were seen 1000 ft or more above the canopy (Table 1)—birds crowding and spiralling immediately over the cave gorge to come in the dusk inrush are not feeding (Medway 1962 : 231 agrees). The large majority move between 20 and 800 feet, without recognizable stratification (Harrisson 1963). There may be a tendency for *maxima* to feed higher at times, but no distinct or regular trends could be found—certainly not to the extent postulated quite theoretically by Medway (1962 : 243), who put *salangana* at ' intermediate ' levels and *maxima* higher.* Except directly over limestone, any swiftlet (and perhaps any insect ?) above 1500 feet super-canopy is quite a rarity (Harrisson 1966 : 419).

In March 1967, with *maxima* nesting strongly, a special effort was made to search higher air levels in case birds had previously been missed. None were located.

The evidence so far in this difficult aerial field indicates *maxima* only erratically flying high but tending to go further afield and stay out longer when ' necessary ' (see below).

(iii) ' *Swarming* '

Collocalia concentrations of *c.* 50 to *c.* 500 were seen associated with dense swarms of unidentified flying insects, again very erratically. Swarming ants and termites may be periodically crucial in the food supply (III below). Unfortunately, almost nothing is known on controlling factors in the region (see Appendix).

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* In the summary of his long paper, Medway (1962 : 245) restates his earlier hypothesis as if it was proven (' *C. maxima* feeds higher than *C. salangana* '). Interestingly, the larger *C. gigas* of Java ' tends to feed higher ' than other *Collocalia*, according to Becking (1971). But elaborating, this experienced observer makes clear his observation was largely over *open* country, and that *gigas* came low also ' in particular when there are flying termites ' (Becking 1972). All but one of the few *gigas* records for Borneo are low-flying in the open (Smythies 1968). There is no present evidence that ants or termites swarm tropically *high*, rather the contrary (Nutting 1969; Deligne 1972).

(iv) *Movements through the cave formation*

The broad flow patterns into and inside the limestone have been very adequately described by Medway (1962). Further study, incorporating mist-nets (since 1964), requires only three new emphases (T.H.):

(1) More swiftlets, especially *maxima*, stay out part of the night than was earlier recognized, especially with clear moonlight.

(2) Both fly at all levels inside, according to internal topography, though the proportion of *salangana* tends larger lower down towards the floor.

(3) Although rain and storms visible from the caves immediately inhibit *Collocalia* movements in the vicinity, on a wider view they can, like other swifts, operate around considerable storm patterns (cf. Lack 1958). This can be a factor delaying evening return, too (and cf. Nutting 1969).

III. LABORATORY ANALYSES

(i) *Stomach contents*

Many swiftlets netted on the dusk inrush have the stomach so distended that it bulges conspicuously through the belly skin. But returning-to-rest birds are equally often almost empty, including at peak nesting (March-April).

Contents of a full *salangana* stomach weigh near 1½ grams, *maxima* 1½ to 2 grams, averaging near 11% body weight. 100 full stomachs examined on the spot had 27 to 232 individual insects (cf. Table 7) most of those over 100 in *salangana*. Numbers depend primarily on proportions of tiny beetles and flies (2-4 mm) rather than larger types of termite (13 mm) and ants (see Table 11).

We can estimate that the year round Niah Swiftlets *eating well* could daily use *c.* 5000 kilos; involving not less than 100,000,000 individual insects each 24 hours?

Nestling stomachs (65) show the same varying food types as adults in other seasons (Tables 2-5). A 21-day *maxima* was distended with 26 whole ants, 6 large termites and beetles (11+ species); at the other extreme, a 3-day chick had only tiny hard beetle fragments. Fledgelings under favourable conditions can survive without food for 15+ days, an important ability under these conditions (see below).

(ii) *The food spectrum*

In addition to on-the-spot stomach examinations (as above), 41 were preserved for fuller laboratory study. This was undertaken with the most generous help and expertise of Dr G. H. L. Rothschild (1965-8), research entomologist in the Department of Agriculture, Sarawak; and later extended at Cornell University, N.Y., with the generous and patient help of Dr W. L. Brown Jr. (1968-71), Professor of Entomology there and Hon. Curator of the important Harvard University collection of ants, on specimens which could not be adequately identified earlier in Borneo. The results incidentally give the first information on what, other than birds, moves over the Borneo canopy.

The main material was 23 *maxima* and 18 *salangana* netted in dusk samples, November and March (breeding peak) at Niah, with a separate February check sample from the Kakus caves, 100 miles to the southwest (10 *maxima*, 3 *salangana*). In view of the many lacunae in area entomological knowledge, identifications were aimed at main groupings only.

Over half the food materials were Hymenopteran; at times this reached 99% for *maxima* (Table 4).

TABLE 2

THE ORDER HYMENOPTERA IN *Collocalia* STOMACHS

Family		Subfamily	*C. salangana*	*C. maxima*	Minimum no. of species involved
Formicidae	Ants	Camponotinae	very common	v. common	6
		Myrmicinae	abundant	abundant	15
		Ponerinae	occasional	fairly regular in small nos.	4
Ichneumonidae	Parasitic wasps		fairly regular	none	3
Chalcidoidae			occasional	none	2
Meliponidae	Stingless bees [*Trigona*]		*once	once	1
					31

Five other insect orders are present, with 34 species; though in actual frequency the alate of one large Macrotermitinae species dominates this sector (Table 7, etc.).

* See Appendix.

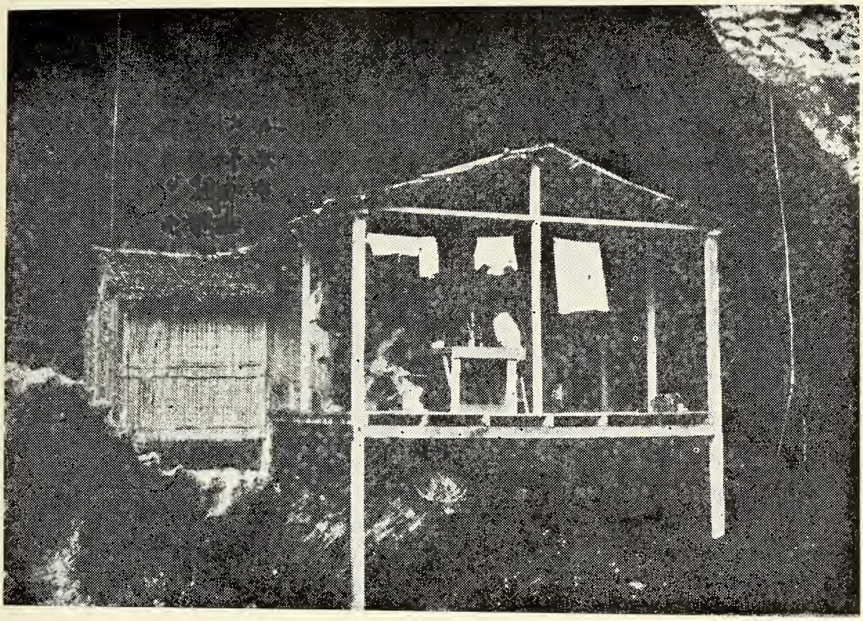

Fig. 1. Field laboratory for cave studies, Niah Great Cave, Sarawak.
(*Photo*: *Barbara Harrisson*)

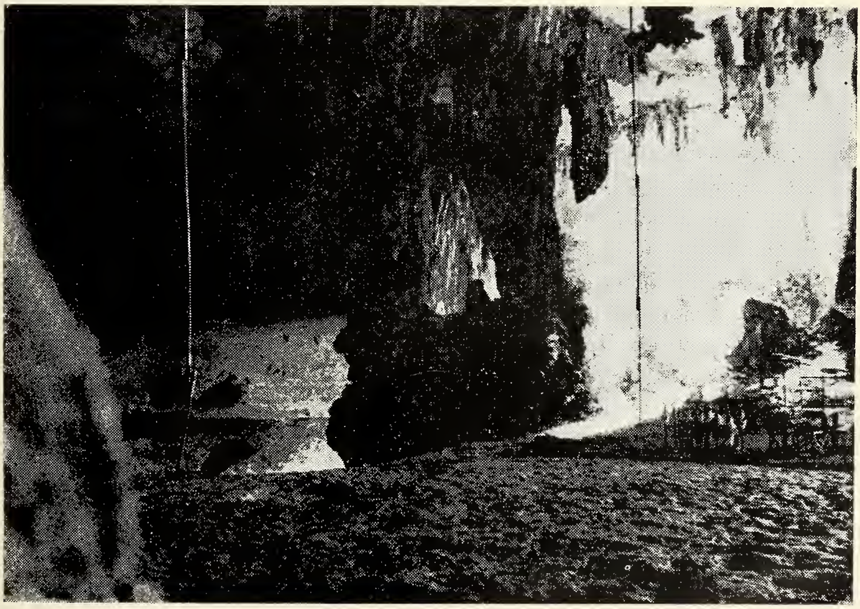

Fig. 2. Part of west mouth of Niah Great Cave, showing mist-netting area near big central stalactite and two birds-nester's climbing poles (up to 200 ft high).
(*Photo*: *Christine Harrisson*)

TABLE 3

OTHER INSECTS IN *Collocalia* STOMACHS

Order	Family		*C. salangana*	*C. maxima*	Minimum no. of species involved
Coleoptera	Platypodidae		common	once	3+
	Histeridae		once	none	1
	Scolytidae	Woodborers	common	occasional	3
	Elateridae	Click-beetles	regular in small nos.	once	4+
	Brenthidae		once	none	1
	'Other beetles'		occasional	fairly regular	2+
					14
Hemiptera	Lygaeidae	Plant bugs	fairly reg.	fairly reg.	4
Homoptera	Cicadellidae	Leaf-hoppers	occasional	none	2
	Delphacidae	Plant-hoppers	once	none	1
					7
Diptera	Culicidae	Mosquitoes	fairly reg.	occasional	4
	'Other Nematocerid flies'		occasional	once	1
	Stratiomyidae		occasional	once	1+
	Lauxaniidae		once	none	1
	Cylindrotomidae		once	none	1
	'Other Brachyceran flies'		occasional	occasional	2+
					10
Isoptera	Termitidae (Macrotermitinae)		abundant	very common	3
				Grand Total:	34

Since we do not know anything about invertebrate life super-canopy, it is not possible to assess how far these two lists, covering 65 species of 5 orders, reflect a cross-section of available flying food. The absence of a single Orthopteran may be noteworthy, though these are mostly large (over 15 mm) in Borneo. Light-winged Trichoptera and Odonata (dragonflies) are also possible absentees. Softness or hardness alone are not final selective factors, since both swiftlets tackle the hardest-headed Carpenter Ants (e.g. *Colobopsis*) as well as tiny mosquitoes; these have been identified in nestlings, too.

(iii) *Ants in particular*

One occasionally finds adult *salangana* without ants (e.g. one with 21 termites and 51 other insects, Nov.) and *maxima* often without termites and with only a few ants (min. 5). But ants remain constantly the commonest feed, though sometimes flooded out by larger, fatter termites. Dr Rothschild calculated the gross stomach contents for the two Niah samples:

TABLE 4

PERCENTAGE OF FOODS IN *Collocalia* STOMACHS (& cf. Table 6)

Food	NOVMBER *C. salangana*	 *C. maxima*	MARCH *C. salangana*	 *C. maxima*	'Average' both species
Ants ..	57%	46%	37%	99%	60%
Termites ..	33	43	32	0	27
Other ..	10	11	31	1	13

Termites are of three unidentified 'types' (i.e. at least 3 species ?), all Macrotermitinae. Type 1, fattest and largest (13 mm) comprises two-thirds of such food ; type 2, fat but small (3·5 mm) forms about one-third ; type 3, tiny (2 mm), only 1%. Type 1 frequently occurs alone ; 2 and 3 usually mixed with 1.

By contrast, we have at least 25 species of ants identified to genus or beyond. In Professor Brown's view the forms represented are those from the whole range of ants one might reasonably expect to find in Borneo. His subsequent examination confirmed Dr Rothschild's earlier (1968) view that 'the two echo-locating swiftlets of Niah consume the whole taxonomic spectrum of flying ants, without any *entomologically* discernible specialization or exclusion'.

From 19 stomachs the sex for 40 ants of 12 genera was determined. A heavy female preponderance, 35 : 5, is consistent with their generally much fatter swarming condition (see Appendix). Significantly, in no case were both sexes of the same genus found.*

Sexed ants were : 5 MALES—*Paratrechina* (2), *Rhopalomastix* (2), *Amblypone* (1) ; 35 FEMALES—*Camponotus* (11), *Crematogaster* (5), *Cladomyrma* (5), *Pseudolasius* (4), *Petramorium* (3), *Hyponera* (3), *Brachyponera*, *Trachymesopus*, *Pheidologeton*, and 'a small myrmicine'.

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* Every identified ant of all three subfamilies was found at least once, usually several times, in both *salangana* and *maxima*.

Other, unsexed, genera include *Colobopsis*, *Polyrachis* and *Solenopsis* (all common), probably *Emeryopone* and several unnamed myrmicine genera.

The following were identified down to species :

Trachymesopus darwini—the very common ‘ flying ant ’ at lights in settlements in Borneo ; not common in cave food.

Tetramorium guineense—a world-wide ‘ tramp ’, originating in Africa ; *mainly* terrestrial ; twice in food.

Camponotus of *cottesi* and *impressus* groups—big-headed Carpenter Ants ; very common in this food, including over a third of all the March *maxima* samples (sparsely in *salangana* then).

Brachyponera jerdoni—occasionally, singly, in food.

38 stomachs provided satisfactory material to check the number of ant genera present, a point relevant to the number of swarms foraged in any one food-sequence.

TABLE 5

NOS. OF ANT GENERA IN 38 *Collocalia* STOMACHS

No. of genera identified	% of all birds (both species) in this number	
One only	26%	63%
Two	37	
Three	18	
Four or Five	12	
Six or more	7	

Out of the quarter taking simply one ant-form 4, all *maxima*, had *nothing* else to eat. The rest had supplementary termites or other insects. Moreover, no one adult had more than 16 of any one ant-form. Notable in comparison was a well-grown *maxima* nestling (19 November) with ants of at least 9 species, along with 5 large termites, a whole borer-beetle and 2 fragmented flies.

(iv) *The total meal*

To see the food pattern more closely (cf. Table 4) let us next glance at a single sample of 13 adults caught in one mist-net within dusk-rush minutes, 29 March. Both species then had young in nest ; and *maxima* nest-harvesting was over. (A minority, this day estimated under 5%, had come in before inrush.)

TABLE 6

13 *Collocalia* STOMACHS IN SINGLE INRUSH NET (29 MARCH)

Species	Sex	No.	No. of Ants		No. of Termites		No. of Other Insects	Total all
			smaller mostly	larger mostly	Type 1	Types 2-3		
salangana	♂	4	181	1	79	34	196	491
	♀	4	81	2	94	48	25	250
		8	262	3	173	82	221	741
maxima	♂	3	14	147	0	0	0	161
	♀	2	18	4	0	0	1	23
		5	32	151	0	0	1	184

On this flash-sample, there is a clear-cut distinction: *salangana* on termites, smaller ants and other insects; *maxima* on larger ants. But individual variation is high. Indeed 1 ♀ *salangana* had zero termites and accounts for 127 of the 'other insects', while ♂ and ♀ *maxima* had only smaller ants. Species and sex differences are immediately diluted by comparison with another sample. For instance, if we switch a month earlier and 100 miles to the Kakus caves, further inland, with smaller numbers of both species living together in the same way, the apparent *salangana* dependence on termites vanishes. Neither swiftlet has taken one. Or going back to November at Niah, some of both *maxima* and *salangana* were then distended on termites, others had none, though as in March the smaller bird had considerably more termites, especially the largest (Type 1).

TABLE 7

AVERAGE OF 3 INSECT GROUPS PER STOMACH, 3 PERIODS

Month	Species	No. in sample	Average no. of individuals per stomach of			All three
			Ants	Termites	'Other'	
November	*salangana*	7	25	14	5	44
	maxima	9	7	5	1	13
February	*salangana*	3	22	0	6	28
	maxima	9	11	0	1	12
March	*salangana*	8	33	32	28	93
	maxima	5	37	0	0	37

On each occasion *salangana* had more than twice as many items per bird as *maxima* (cf. III, vi). The total termitelessness of March *maxima* (Table 7) was repeated for both in February, but neither in November. The process can be clarified another way :

TABLE 8

NOS. OF *Collocalia* STOMACHS WITHOUT A SINGLE EXAMPLE FOR 3 GROUPS (3 PERIODS COMBINED)

Species	No. of birds	Individual stomachs without one :		
		Ant	Termite	'Other'
C. salangana	18	2	8	5
C. maxima	23	2	21	15

This well brings out the relative frequency of termitelessness, and the correlated but lesser neglect of any insect other than ants. One of the two termite-eating *maxima* above had *only* termites, 36, entire. Several *maxima* nestlings and adults earlier examined at the caves had whole large termites too.

(v) *Swallowing and fragmentation*

Swiftlets swallow whole insects of all sorts. There are, however, notably often fewer termite wings than bodies in stomachs (see vi). Some smaller items, especially Diptera, rather surprisingly remain intact—even with wings after transfer from adult food 'pellet' to nestling stomach. For others, especially beetles, both whole ones and separate hard elytra occur, as with two March *salangana*.

TABLE 9

BEETLE (ONLY) REMAINS IN TWO *salangana* STOMACHS

Family		Length	Bird no. 1	Bird no. 2
Platypodidae	..	3·5	50 whole + 78 elytra	12 whole + 26 elytra
Scolytidae	..	2·5	12 whole + 25 elytra	13 whole + 26 elytra

This suggests long survival of some hard parts which may well serve a secondary function, remaining in a slower digestive cycle than is presently understood and perhaps peculiar to *Collocalia*—which already has nest salivation and echo-location as precedent specialisms for success in this remarkable cave-niche.

(vi) *Size factors*

From complete or re-assembled specimens we were able to calculate the original body size of nearly all the food insects. This further labour seemed essential in view of the above somewhat negative conclusions on species-differentiation by other criteria, as well as to test a second suggestion (cf. II, ii) by Medway to explain the Niah *Collocalia* situation. Following general western theory (cf. Lack 1947) he concluded (1962 : 240) that as 'the two species must have different ecology' so, where feeding overlaps aerially, they each 'select different elements from the airborne prey' according to bill size. This was re-examined at Niah in 1965. Consistent with longer wing and higher body weight, *maxima* gape there averages *c.* 1 mm more than *salangana.* Does this directly affect size intake?

In the case of the 'other' insect group, the problem hardly arises, since over 95% of these are *c.* 5 mm or less.

TABLE 10

APPROXIMATE BODY LENGTH OF VARIOUS 'OTHER' INSECTS TAKEN REGULARLY BY *Collocalia*

Order	Family	Average length (mm)	Maximum length (mm)
Hymenoptera	All wasps, bees	2·0-3·5	5·0
Hemiptera	All sorts	3·5-5·0	5·5
Coleoptera	Scolytidae	2·0	2·5
	Platypodidae	2·0-3·0	3·5
	Elateridae	3·0-4·0	5·0
Diptera	All sorts	2·5-3·0	3·0

At this size level, clearly no size differentiation by bird species can be detected ; indeed the slightly larger wasps and bugs are, on these data, less likely to be taken by the larger bird (cf. Tables 2 and 3). It is fairly safe to suspect both swiftlets may take pretty well anything of this size they come across, and that the absence here of a few small items for *maxima*—only one of which occurs at all regularly with *salangana* (Table 2)—is partly chance on small series, though partly, also, a reflection of a less *positively* 'omnivorous' approach and relatively less consumption of beetles and flies perhaps.

The earlier noted absence of certain other possible super-canopy forms, such as tiny dragonflies, need not be truly selective, but for the less obvious reason that with such insects in flight *stiffness* or angle of wing, rather than actual span, may restrict the capacity to swallow. Although larger winged termites and some large flying ants are taken at more than twice the sizes of Table 10, the wings of many of these fall off or fold inward on touch (Nutting 1969 : 258 ; T.H.). It is extremely difficult to differentiate all such wings in stomach analysis. Certainly, of 255 measured termites taken, 67% were over 12 mm long ; present in both swiftlets but mainly *salangana* (Tables 6-8).*

The 25 ant species present a more complex problem. These range from 2·5 to 12·5 mm, mostly 5-10 mm. Only a few, mostly Carpenter Ants, run as large as Termite Type 1 (over 12 mm). Thus the 'middle-sized', 6-12 mm, niche in this material is *exclusively* filled by ants, and only these fall within that category below :

TABLE 11 (cf. Table 7)

SIZE RANGE OF 1530 MEASURABLE INSECTS FROM *Collocalia* FOOD

Month	Species	No. of insects	Percentage of this length-range		
			−5·5 mm (small ants, termites, & all 'others')	6-12 mm (larger ants)	12+ mm (largest ants & larger termites)
November	*salangana*	284	36	54	10
	maxima	132	58	11	31
				42	
February	*salangana*	83	98	2	0
	maxima	108	37	62	1
				63	
March	*salangana*	740	67	9	24
	maxima	183	23	77	0
				77	
		1530			

Thus, although smaller *salangana* regularly has twice as many insects as larger *maxima* (Table 7) and dominates the larger termite sector in proportion to the latter bird's smaller gross intake, twice in three times *maxima* has well over half its food in the middle range ; and when *salangana* dominates here (with the same ant species), *maxima* has stepped up the food size. Therefore—as usual—there is no exclusivity for either species by size. But there is a significant tendency for *maxima* to eat fewer and larger items, especially in the *middle* size range.

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*A thoughtful new study of swifts feeding in Puerto Rico shows a big March-August insect peak, with over 90% of available insects less than 5 mm long, only 1·2% exceeding 10 mm, and severe food supply limitations on two swift populations (Kepler 1972).

We have recalculated these and other figures in other ways, without any fresh insights resulting. In the end it has to be concluded that size alone is not a direct and dominating selective factor except in so far as both species are equally restricted by the nature of their shared feeding processes. Size can, within these limits, be varied according to the overriding consideration of food availability—and chance encounter.

IV. How much do *C. salangana* and *maxima* differ in food habits ?

1. This limited study has been surprisingly unsuccessful in defining any distinct or consistent differentiation or specialization of feeding habits or food for two sympatric *Collocalia* breeding numerously together in Sarawak caves and feeding together in the super-canopy.

2. There is an indistinct *tendency* for larger *maxima* to fly further, stay out longer and go longer on less ; and even more erratically to fly a little higher, though apparently both swiftlets intermix completely at (crucial) ant/termite swarms (cf. 7 below).

3. *C. maxima*, however, seems to 'prefer' more large fat female ants, *salangana* more large termites, small ants and other small insects (Tables 10-11). But there is much bird-to-bird and day-to-day variation and overlap, especially when swarms are scarce. At times either bird 'might take anything manageable that's flying' (Dr Rothschild agreeing with writer).

4. Of 22 families and subfamilies of insect identified in *salangana* stomachs, 8 were not recorded in *maxima* (Tables 2-3) ; but only 1 of these was other than occasional (rare) in the former. Rothschild calculated food common to both birds on three main samples :

Table 12

November	23%
February ..	66%
March ..	6% (fewer *maxima* in sample)

Taking all three lots and refining further from Dr Brown's later ant-analysis, 94% by insect item and about 98% by bulk was of forms found in both birds at least once. All the common foods (ants, termites and two beetle families) were at some stage shared.

5. Looked at another way and momentarily forgetting western ideas applied to the Indian sub-regional equatorial setting, it might even seem stranger that two so-close bird species ate differently in identical context than that both ate everything available (and exclusive to them) they could equitably swallow, especially since there is significant supporting evidence that insect food of *all* kinds may be in highly erratic supply seasonally (Ward 1969 for Singapore ; Fogden 1972 for Sarawak ; cf. Kepler 1972 for Puerto Rican Swifts).

6. Differences might be sought elsewhere. Collection and utilization of nest materials, with associated tactile habits, are suggested as one sector, and will be the subject of a following paper.

7. A residual (difficult) question remains : why does *maxima* often seem to be taking less food, both by numbers and to a lesser extent weight ? The verb ' seem ' is used purposefully. It is possible that this result is methodological. In retrospect, netting more birds coming in full darkness might have been illuminating, though it cannot have changed the overall picture as regards food spectrum. But if, as is quite likely (cf. Appendix), some ants and termites (especially) swarm best after sunset and into full dark, the writer may have too readily followed Medway in accepting that echo-location would not be used for nocturnal swarm-feeding. Alternatively, it could be that *maxima*, with its special nest-salivation and single-egg rhythm may use relatively less energy consumption than *salangana*, which also has a shorter wing ratio ? The question remains open.

APPENDIX : Swarming Insects (cf. II, iii and Tables 5, 8)

The periodicity and distribution of flying ant and termite swarms are evidently crucial for Niah *Collocalia*. The matter has lately been touched upon in another and extensive Sarawak Museum study by Dr Michael Fogden (1972 : 315), apropos general forest bird food, although he only considers termites. As with the wider flying insect problems we are once more faced with very meagre entomological or ecological information. It is agreed that for ants the males swarm first, fly less erratically and are much thinner (by then) than the females which next fly up *slowly*, in prime condition (cf. 7 : 1 sex ratio in III, iii), to copulate. With termites, the swarming is constantly bisexual and copulation occurs *after* falling ; there is no big female preponderance, but both sexes are almost equally fat.

Both Professor Brown (1969-71) at Cornell and Professor l'Abbé G. Van Boven (1972) at Louvain University, Belgium (specializing in tropical Africa) consider that in Borneo's equatorial and climatic conditions, ants and termites of one species or another *might* be swarming on almost any day of the year, subject to weather and other variables. Dr Jean Deligne, University of Brussels, qualifies this view for termites and suggests there may be considerable periods of little or no swarming in Borneo. He has observed this specifically in West Africa (Deligne 1970, 1972), while marked seasonal periodicities have been reported in arid Arizona and equatorially. Single, short-duration flights only once a year have been demonstrated as normal for at least one species of Macrotermitinae (of the very few studied) in tropical Congo and India (Nutting 1969; cf. Wynne-Edwards 1962 for 'advantages'). In the Philippines *Macrotermus gilvus*, common through Southeast Asia, swarms in great numbers at dusk from May to September (Uichanco 1919). *M. insperatus* in Java swarms profusely for a bare 15 minutes at dusk from late October to mid-November (Roonwal 1970).

Bees are also differently involved. Both Niah *Collocalia* have been recorded with tiny stingless Meliponidae, probably genus *Trigona* (Schwarz 1937). These 'swarm' feeding on the suddenly, erratically, seasonal flowering crowns of great fruit-trees along the Niah river. I have seen all three Great Cave swiftlets taking them thus. But whereas *C. esculenta* (and *Hemiprocne longipennis*; see Smythies 1968) will take many, both *salangana* and *maxima* usually stay a minute or less, do not forage such bees systematically. This appears to be definite negative selectivity?

Suitable super-canopy insect swarms present concentrated rich food prizes for swiftlets, uniquely. But these surely occur with much spatial and periodic erraticism, and their absence poses almost equally severe problems of difficulty. Swarms cannot be relied on!

Moreover, as individual termites and ants fly once in a life-time, it seems unlikely that even 'in season' they can be *continuously* available in the required massive daily densities. On the other hand, colonies have been censused to several millions, with the termite alate (flying) proportion up to 43%. An annual alate production of 200,000 per acre estimated in Nigeria seems inadequate for Niah-type needs (Nutting 1969; 237); but density may be far higher in rain forest? I hope in the near future to elaborate on this theme, with some fresh field observations—especially nocturnal.

TOM HARRISSON 10/72

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Physiological adaptations in the Rosy Pastor wintering in India[1]

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Introduction

The physiology of bird migration has been the subject of extensive investigation for many years in my former laboratory at the Maharaja Sayajirao University of Baroda (latitudes 20-24 and longitudes 72-76), Gujarat, India. The Rosy Pastor or the Rosecoloured Starling [*Sturnus roseus* (Linnaeus)] has been one of the most intensively studied species of migrants wintering in the area. With the establishment of a centre for the study of the physiological basis for animal migrations at the University of Guelph in Canada, it has become possible to collaborate with former colleagues at Baroda in continuing some of the studies and also extending them to species of the northern hemisphere.

In any physiological investigation on a wild species, reliable field information regarding its distribution and natural history is a prerequisite. In my own studies on the Rosy Pastor as well as on other species of Indian birds, I have had to draw constantly from Sálim Ali's experience. On occasions when he pulled me out into the field with him, he generously shared with me his incredible enthusiasm and wealth of knowledge. I consider this opportunity of associating myself in the felicitations on the occasion of his 75th birthday a unique privilege, since another one of his kind may never be.

According to Sálim Ali (1955), the Rosy Pastor is one of the earliest winter visitors to India, abundant in the north-western parts. They arrive in July-August and leave about the middle of April and return to their breeding grounds in eastern Europe, western and central Asia, where they nest in May and June. Their breeding is known to overlap that of the migratory locust, thus ensuring sufficient supply of food for themselves and their young.

On arrival in Baroda, they are greeted by the monsoon rains and plentiful supplies of insects as food. Toward their departure in late April, the ambient temperature in Baroda may go up as high as 110°F or more, after an intervening period of the cool tropical winter. Toward

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migration their diet becomes mostly, if not entirely, vegetarian consisting of banyan and pipal figs and various types of berries. The fruits of *Pithecolobium dulce*, locally called *goraz amli*, seems to be a major food item during the fattening period prior to migration. The difference in the day-length between the winter and spring (summer) months is relatively insignificant compared to that in the Temperate Zone. Nevertheless, the changing environmental conditions do impose on the bird the necessity of adaptational changes in the body.

NATURE OF ADAPTATIONS

The adaptational changes in the body of a migratory bird may be regarded as the result of a dialogue between the environment and the biological organization within. These changes evidently occur at various levels of organization, thereby affecting the physiology and behaviour of the organism as a whole. The physiologist therefore seeks to investigate the influence of environmental factors such as light, temperature, humidity etc., structural and metabolic adaptations, the mechanism of internal regulation which possibly determines the actual timing of migration and the processes involved in the generation and utilization of energy for migratory flight. These aspects of the physiology of the migratory bird embrace practically all basic life processes and the revelation of these principles should lead ultimately to an understanding of the very nature of life itself.

This review deals mainly with the work done, under the auspices of the M. S. University of Baroda, on the Rosy Pastor from the time of its arrival in Baroda to its departure for its breeding grounds abroad. The exact time of their arrival in Baroda is not known but small groups are quite common about September. This phase will be referred to as the postmigratory phase. Towards March, they flock together into larger groups and by April end, form large migratory swarms [see photograph by Sálim Ali (1955) ; Plate 72 facing p. 127]. This phase will be referred to as the premigratory phase. The adaptational changes occurring in the various tissue and organ systems will be considered under these two phases.

INTERNAL REGULATION

The hypothalamus is well recognized as the seat in the brain that controls numerous autonomic and endocrine functions. It contains neurosecretory cells some of whose secretions are transported to the hypophysis through portal circulation while others are stored and released from the neurohypophysis. The hypothalamus has also been shown to be controlling the regulation of food intake. A normal mature animal maintains its body weight fairly constant, which is indicative of a regulatory mechanism operating to balance energy intake with output. It has been demonstrated in several laboratory mammals that two areas in the hypothalamus are responsible for the regulation of food intake. The studies of the Indian physiologist B. K. Anand and his associates (1955) have provided experimental evidence to show that the lateral hypothalamic area is involved in increased daily food intake and the medial area in decreased food intake. It is well known that migratory birds deposit considerable amounts of fat in the body prior to migration. Rosy Pastors have been found to weigh 50-60 g in October and 80-125 g in April (Naik 1963) the increase in body weight being, by and large, due to the deposition of fat. Kuenzel & Helms (1967) have produced obesity in the migratory Whitethroated Sparrow by experimentally creating lesions in the ventro-medial area of the hypothalamus. In the light of these observations, the hypothalamus may be considered as not only the link between the brain and the endocrine complex but also as the site where the initial triggers, that control the sequence of events in effecting migratory activity, reside. George & Naik (1965) have described the hypothalamo-hypophysial neurosecretory system of the Rosy Pastor. The hypothalamic neurosecretory centres consist of the supraoptic and paraventricular nuclei, and the anterior and posterior divisions of the infundibular nucleus as revealed by staining with paraldehyde fuchsin as well as Gomori's chrome alum haematoxylin phloxin for neurosecretory material. The granular neurosecretory material presenting a beaded appearance was traced from the cell body along the axon to the regions of distribution and storage depots. The intensity of staining in the cells was considered an index of their secretory activity and that in the storage areas, the extent of accumulation of the neurosecretory material. On studying the intensity of staining of the neurosecretory material in birds collected during the postmigratory and premigratory phases, they observed certain definite cyclic changes. During the postmigratory phase (October/November), the amount of the neurosecretory material in the supraoptic and paraventricular nuclei, the median eminence and the neurohypophysis was found to be relatively low compared to that in the premigratory phase. Towards February, there was slight increase but no perceptible change was noticed until the end of March. From the last week of March, there was distinct increase, especially in the supraoptic and paraventricular nuclei, the tractus tubero-hypophysis and the neurohypophysis. The neurosecretory cells were found to be conspicuously larger with the nuclei and nucleoli also increased in size and surrounded by a larger amount of cytoplasm. The axons of the cells also were easy to trace due to their high content of neurosecretory material. A few days prior to migration, however, the neurosecretory material was found to be considerably depleted in the neurohypophysis, presumably released into the general circulation. The reduction in the neurosecretory material was also noticed in the other parts possibly released and dispersed into the anterior pituitary through the portal circulation. This release of the neurosecretory material was considered a trigger in initiating the chain of events that follow in the migratory process. In a study of the localization and intensity of the activity of the enzymes, acid and alkaline phosphatases in the hypothalamo-hypophysial system, Naik & George (1966) observed considerable increase in the enzyme activity towards migration time. They correlated these changes with increased production and release of the neurosecretory material. John & George (1970) studied histo-chemically the localization and intensity of lipase activity in the hypothalamo-hypophysial system in the post- and premigratory periods. The enzyme activity was found to be increased in the premigratory phase in the hypothalamic neurosecretory nuclei, median eminence, pars nervosa and adenohypophysis. The increase in the enzyme activity has been correlated with increased lipid metabolism in these regions.

If the release of the neurosecretory material were to influence the regulatory mechanism in the body, evidently significant changes in the master gland in the body, the anterior pituitary, should be expected. Extensive studies on the mammalian pituitary have shown the relationship between the various cell types and the hormones secreted by the gland. In a cytological study of the pituitary gland of the Rosy Pastor using histo-chemical staining techniques, Naik & George (1965a) distinguished six types of chromophil cells consisting of three types of acidophils : Small orange G cells (prolactin [LTH] cells), Large orange G cells and Acid fuchsin cells (ACTH cells) ; and three types of basophils : Purple cells (TSH cells), Deep green cells (FSH cells), Light green cells (LH cells). Functionally these cells are believed to be responsible for the production of the hormones indicated in brackets against each cell type. The cell type for the growth hormone could not be identified. A general increase in the number and activity, as indicated by size and staining intensity, was noticed in all cell types towards migration.

A few days prior to migration, the purple cells showed signs of degranulation. This coincided with the release of the colloid in the thyroid gland (George & Naik 1964a). A study of the serum tyrosine level which is indicative of thyroidal activity, by Pilo & George (1970a), showed that the peak level of 104 microgrammes per millilitre was reached towards migration time (last week of April).

The increase in the number of the deep green cells was found to be associated with the development of the testes in male (Naik & George 1964a). With the release of the colloid from the thyroid, the development of the testicular elements ceased at the stage of primary and secondary spermatocytes, to be resumed after migration at the breeding grounds. Parallel changes in the females were considerably slower, which probably accounts for the fact that females leave later.

Prolactin has been implicated as a factor in fattening leading to migratory activity. The increase in the small orange G cells is in accordance with this contention.

The increase in the acid fuchsin cells prior to migration was reflected in the increased production of corticoids in the adrenal towards migration (Naik & George 1963). Increased production of ACTH is also of significance since this hormone is known to be a fat-mobilizing hormone. The transport of fat from the adipose tissue to the muscles as a hormone-mediated process is now well established. Histological and histochemical studies (Naik & George 1965b) on the adrenal have demonstrated striking seasonal changes in the adrenal cortex. Towards migration there was considerable increase in the amount of RNA and fat and also in mitochondrial density, thus presenting a sort of hypertrophic condition in the cortex. These changes might have been influenced by increased ACTH production. The above changes in the adrenal were also found to be accompanied by increased activity of alkaline phosphatase in the cortex and of acid phosphatase in the medulla (Naik & George 1964b).

The ascorbic acid (Vitamin C) content of the adrenal was found to drop towards migration (John & George 1967b). They suggested that this drop in ascorbic acid might be a factor in stimulating the production of corticosteroids and adrenalin. Cholesterol is known to be a precursor of steroid hormones. John & George (1967a) found a marked increase in total cholesterol in the adrenal from February to April, the increase in February being significantly more than that in April. They suggested that cholesterol was being rapidly converted to corticosteroids with the aid of ACTH which was also expected to be significantly increased (Naik & George 1965a). The role of ACTH in the conversion of cholesterol to corticosteroids has been discussed by Hayano *et al.* (1956). In the production of adrenalin, tyrosine is known not be a precursor while phenylalanine is believed to have a role in the synthesis of adrenalin. In a study of the seasonal changes in the concentration of these two amino-acids in the adrenal, John & George (1967c) found that the peak was reached in the month of February and the trough towards migration time. This drop in the amino-acid level has been correlated with the decrease in ascorbic acid and also with increased production of adrenalin towards migration time.

The adipokinetic as well as hyperglycaemic function of glucagon and the hypoglycaemic function of insulin, the two hormones produced by the alpha and beta cells respectively in the islets of Langerhans of the pancreas, are well known. George & Naik (1964b) observed an increase in the number of islet cells mainly through the conversion of the acinar cells during the premigratory phase. With the increased activity of the beta cells the high blood-sugar level in the month of February began to decline, reaching a low in April, obviously with increased production of insulin. Consequently, the high sugar intake was diverted towards fat synthesis.

PREMIGRATORY FAT DEPOSITION

That migratory birds deposit large amounts of fat prior to migration is common knowledge. Fat mainly in the form of triglycerides is stored in the adipose tissue present in the different regions of the body, the abdominal fat pad being the most prominent. Unlike in mammals, the adipose tissue in the avian body is not known to be an active site for fat synthesis. Most of the synthesis of fat is believed to take place in the liver in birds. George & Naik (1963) discovered certain haematopoietic nodules in the liver of the Rosy Pastor which were also found to be sites of fat synthesis. These nodules were found to be most active in the production of different types of blood cells—erythrocytes, granular leucocytes, lymphocytes and monocytes, during the premigratory phase. Fat was found to be synthesized by the lymphocytes, monocytes and free moving reticulo-endothelial cells, the main synthesis being in the reticulo-endothelial cells. Though fat is not actively synthesized in the avian adipose tissue, the tissue as such has been shown to be a metabolically active tissue, much more so in the Rosy Pastor than in the domestic fowl (George & Eapen 1958, 1959). Naik (1963) studied the water, fat, protein and glycogen content of the liver of the Rosy Pastor in the post- and pre-migratory phases. He observed that the body weight increased from 51-58 g in October to 80-125 g in April prior to migration. While the water and protein contents of the liver decreased towards migration time, fat and glycogen content increased. The increase in body weight was by and large due to the deposition of fat in the adipose tissue. Blood fat in transit was also high towards migration time. An enzyme, lipase, known to be responsible for hydrolysing fat into fatty acid and glycerol and esterifying fatty acids and glycerol to glycerides, is also known to be a clearing agent for fat in the blood. George & Vallyathan (1961) studied the serum level of lipase activity in the domestic fowl, pigeon and the Rosy Pastor. They found that the Rosy Pastor had a serum lipase level about 10 times that of the domestic fowl and about twice that of the pigeon. The pigeon which is a good flier has a very much higher serum lipase level than a poor flier like the domestic fowl; while the Rosy Pastor, which is a migratory bird, has a considerably higher level than the pigeon.

Seasonal variation in the deposition of fat in birds in general, and the deposition of migratory fat in migratory birds in particular, is well documented (see George & Berger 1966). The role of fat as fuel for muscular energy during migration has been discussed at length by George & Berger (1966). The machinery necessary for metabolizing fat in the muscles therefore becomes a topic for consideration.

FUEL OF MUSCLE

It is well established that the fat content of the chief avian flight muscles, pectoralis and supracoracoideus, is generally higher than the muscles of most other animals (George & Berger 1966). In the Rosy Pastor the fat content of *M. pectoralis* is considerably increased towards migration (Vallyathan 1963). It should be mentioned here that the glycogen content of the muscle is also increased at the same time (Vallyathan & George 1964 ; George & Chandra-Bose 1967). It is possible that during the initial part of flight and also in short flights, carbohydrate would be the preferred fuel, thus sparing fat, and as flight is prolonged, fat would take over as the chief fuel. Even then, some carbohydrate would be metabolized, because the utilization of fat through fatty acid oxidation takes place in the ‘ flame ’ of carbohydrate. Studies on pigeons subjected to electrical stimulation of the pectoralis muscle have shown that fat is transported from the adipose tissue to the muscle through the blood stream (George & Berger 1966 ; Vallyathan & George 1969 ; Vallyathan *et al.* 1970). If fat is to be utilized, it has first to be broken down to fatty acids and glycerol. The fatty acids are then oxidized in the mitochondria, generating free chemical energy in the form of adenosine tri-phosphate (ATP) as the main product and carbon dioxide and water as by-products. It is known that the flight muscles of birds contain a high concentration of the enzyme, lipase, which splits fat into fatty acids and glycerol (George & Berger 1966). It is also known that the avian flight muscle contains numerous mitochondria and high concentrations of oxidative enzymes (George & Berger 1966).

The pectoralis muscle of the Rosy Pastor contains two types of fibre, a red, narrow fibre containing numerous mitochondria and high concentrations of fat, lipase and oxidative enzymes and the other a light, broader fibre considerably fewer in number and containing fewer mitochondria and much less lipase and oxidative enzymes (George & Berger 1966). Using histochemical techniques, George & Talesara (1962) showed that the pectoralis muscle fibres of the Rosy Pastor contain considerably higher levels of oxidative enzymes than those of the domestic goose and the domestic fowl. In another study they (1961) observed that the activity of one of the key enzymes in the Krebs cycle, succinic dehydrogenase (SDH), in the Rosy Pastor was higher than that of the several other birds and a bat studied. They also found that towards migration the

SDH activity in the muscle of the Rosy Pastor reached a peak level, twice that of the level recorded during the postmigratory period. On the other hand lipase activity in the muscle was found to be lower in the premigratory phase (Vallyathan 1963). In a study of the particulate fractions and whole homogenate of the pectoralis muscle in the premigratory and postmigratory periods, George & Vallyathan (1964a) observed that lipase activity was lower in the premigratory phase and SDH activity higher than in the postmigratory phase. The experiments were conducted in the early hours of the morning as well as in the evening so as to know if there were diurnal differences. From the results obtained they suggested that fat was synthesized during the night. George & Chandra-Bose (1967) studied diurnal changes in the levels of glycogen and fat in the pectoralis muscle of the Rosy Pastor during the premigratory and postmigratory periods. Glycogen content of the muscle was found to be higher in the evening than in the morning whereas fat content was higher in the morning. The decrease of glycogen during the night and of fat during the day was explained as due to the preferential utilization of the two metabolites, namely glycogen during night and fat during day time. Prior to migration, however they observed that the level of fat in the morning and in the evening was more or less the same. This observation prompted them to suggest that during the premigratory phase when the body fat reserve was being built up, the bird was utilizing carbohydrate for muscular energy by oxidizing pyruvate instead of fatty acid and thereby sparing fat. Phosphorylase activity in the pectoralis muscle of the Rosy Pastor was found to be higher in the premigratory period (Vallyathan & George 1963, 1964). This also supports the above suggestion.

Experiments were conducted to assess the capacity of the muscle for fatty acid oxidation. George & Vallyathan (1964b) showed that the breast muscle homogenate of the Rosy Pastor in the postmigratory phase had a greater capacity for fatty acid oxidation than that in the premigratory phase and that there was greater oxidation of malate in the manometric system in the latter case. In a comparative study of the capacity for fatty acid oxidation by the breast muscle homogenate of the Rosy Pastor in its premigratory phase, and that of a non-migratory starling, *Acridotheres tristis*, George & Iype (1964) found that it was lower in the Rosy Pastor at that time. They suggested that there exists a control system in the Rosy Pastor which minimizes fat utilization during the premigratory period so as to enhance fat storage. Such a control system should obviously be a hormonal system. Experiments are presently being carried out by George and his associates at Guelph with a view to obtaining a clearer understanding of the regulatory mechanisms involving the secretions of the hypothalamus and the endocrine glands which control the various metabolic processes in the body.

The heart muscle is also known to utilize fat as the major fuel for its energy. George & Iype (1961), correlating lipase activity of the cardiac muscle with the rate of heart-beat, showed that the lipase activity in the heart muscle of the Rosy Pastor was lower than that of the non-migratory starling; *Acridotheres tristis*, indicating a slower heart rate in the former as is known to be the case in human marathon runners.

Sustained flight during migration is possible only if there is a copious and continuous supply of the fuel as well as oxygen. Since the transport of oxygen is the function of the red blood cells, seasonal changes in the blood should be expected. Pilo & George (1970b) studied erythropoiesis in the bone marrow and seasonal changes in the haemoglobin content as well as red cell count in the blood of the Rosy Pastor. Increased erythropoiesis was noticed in the bone marrow in the premigratory period. Consequently, a corresponding increase in haemoglobin content as well as red cell count was seen in the blood. A considerable degree of red cell destruction was found in the liver during the postmigratory period.

Studies on the physiological adaptations in the Rosy Pastor have provided interesting and significant leads towards a clearer understanding of the mechanisms of internal regulation and energy metabolism and have also stimulated further research. Research on these lines would undoubtedly lead to the solution of the riddle of bird migration. The wealth of new information expected to emanate in the years ahead would also have far-reaching implications not only in biology but in medical science as well. While we realize these goals, it is necessary and legitimate to recognize the valuable contributions of field ornithologists that formed the foundation for such studies. In bringing forth the present volume, we pay our tribute to a great ornithologist for his monumental contributions to ornithology in general and to ornithology of the Indian subcontinent in particular.

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The voice of the Indian Hill Myna (*Gracula religiosa*) in the wild[1]

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The northern race (*intermedia*) of the Indian Hill Myna (*Gracula religiosa*) was studied in the field during 1966-7, and the major findings are summarized in this paper. The distribution and general ecology of the species are outlined. Vocalizations are dealt with in detail; all can be classified into one of four categories, one of which ('Calls') forms the bulk of this paper. Birds have repertoires of call types, some of which they share with a few near neighbours of the same sex. The call type last made or heard influences the call type next made. Playback experiments showed that birds can distinguish strangers, neighbours, and their mates by their calls. There is no mimicry of other species, but extensive and complicated vocal imitation of conspecifics, which makes understandable their remarkable imitative ability in captivity.

INTRODUCTION

Sálim Ali (1927) unearthed the best brief description of the Indian Hill Myna I have found, from the writings of the Mogul Emperor Babur in the 16th Century : 'there is another sort ; they bring it from Bengal. It is all black. In its two ears are yellow leathers which hang down and look very ugly. They call it the Maina. It learns to speak well and fluently.' Although known since so long ago, and kept as a talking pet, it is only recently that the Hill Myna has attracted the attention of ethologists, on account of its remarkable ability in captivity to imitate extremely accurately the words of its captors. This ability has caused great puzzlement, since it appeared (e.g. Thorpe 1964) to be an ability which was found only in captivity, partly through lack of knowledge of its vocalizations in the wild. Stuart Baker (1926) referred to Hill Mynas 'copying the notes of other birds freely in the wild state' ; Smythies (1953) appears to have copied freely the notes of Stuart Baker, using identical words. Other authors (e.g. Ali 1941, 1953 ; Delacour 1947 ; Glenister 1951 ; Henry 1955) have been more cautious, and more accurate, referring to the great variety of different noises made by wild Hill Mynas but not mentioning any imitations by them. Clearly a detailed study of Hill Mynas in the wild was called for.

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The author carried out such a study in India in 1966 and 1967, under the sponsorship of the Bombay Natural History Society and the guidance of Dr Sálim Ali. Three months were spent in South India (in the Periyar Sanctuary, Kerala) studying the southern race of Hill Myna; this race has the reputation of being a much less good talker than the northern race. The main cause of the difference is probably, as Sálim Ali (1963) pointed out, that southern-race birds are generally caught as adults, while northern-race birds are taken from the nest when young ; but, as will be reported elsewhere, the southern race produces fewer deep or human-like sounds in the wild, and has much less variety in its calling, and probably even when taken as a nestling makes a somewhat less satisfactory talking pet.

The rest of the study period was spent in North India, mainly in Assam at Kaziranga, but with short visits to other Hill Myna regions and with study of captive birds at Gauhati. Detailed results of this work have been published (Bertram 1970), where will be found data to support the points made in this paper.

GENERAL

(*a*) *Classification and distribution*

In this section it is helpful to elaborate Babur's summary. In Hill Mynas the sexes are identical, both being iridescent black all over except for white wing-patches, orange-yellow beak and legs, and yellow pendant wattles ; these latter, and size, vary according to the subspecies. Ten subspecies of *Gracula religiosa* have been recognized, distributed over south-east Asia from India to Indonesia. In Ceylon, two forms occur, and since they overlap but do not interbreed the form endemic to Ceylon has been given specific rank as *G. ptilogenys* (Peters 1962 ; Ripley 1961). In my view, *G. r. indica* from south-west India and Ceylon also merits specific rank : in their vocalizations this race is completely distinct from *G. r. intermedia* which stretches from Nepal to Indo-China ; in aviaries they do not interbreed or interact with this latter race ; and *G. r. indica* is considerably smaller and with more complex wattle arrangements than the other races of *G. religiosa*.

(*b*) *Ecology*

Hill Mynas inhabit particularly the edges of forest, especially evergreen and semi-evergreen, and thus are found in regions of high rainfall and humidity. They are rarely abundant, being found usually in pairs or small flocks. They fly fast, with their white wing-patches conspicuous. They are basically a resident species, but may move locally, They are mainly frugivorous, but they take nectar, insects and lizards when available, the latter two especially when rearing young. They are completely arboreal, virtually never coming down to the ground.

The onset of breeding coincides with, and is probably triggered by, the start of the rainy season. At this time the small winter flocks split up into their constituent (and probably permanent) pairs, which select a nesting area. They appear to be semi-territorial. They nest in small holes in hollow trees, of many species but especially (in Assam) the Velou tree, *Tetrameles nudiflora*, if available. They build a rough nest of sticks and leaves, collected in a remarkably haphazard manner by both sexes equally. There is almost no courtship before copulation. A clutch consists of 2 to 3 eggs, which are incubated for 13 to 15 days by both birds but more by the female. The young are fed by both parents, largely on regurgitated food ; they leave the nest about 27 days after hatching, and are independent of their parents very soon after this. It is likely that they breed first when a year old. Although their nests may be vulnerable to predation, Hill Mynas probably have few enemies other than Man, who robs their nests for young birds for the sizeable export market. In the Garo Hills, artificial nests are put up in the treetops, and the young birds taken from them (Bertram 1968).

VOCALIZATIONS

(*a*) *Methods of study*

Most of the observations reported here were made on a number of wild individual pairs of adult Mynas at Kaziranga in Assam. The term ' Myna ' hereafter refers only to *G. r. intermedia*, the race of Hill Myna found there. Separate nesting pairs were observed during their breeding season, at the edges of the scattered tea estates and remains of hill forest along the north edge of the Mikir Hills. Thus this was along an east-west line at the edge of their habitat, the country immediately further north being flood plain unsuitable for Mynas. Birds were observed from the ground, when in the vicinity of their nests, the only place where they could be recognized at first, although later this was possible by means of their vocalizations.

Myna noises were recorded with a Nagra tape-recorder and parabolic reflector. Also, a notation system was developed with which it was possible to write down all the noises made by a given pair of birds. Frequently they were very silent, and were then sometimes stimulated to call by playback calls, as described later. Sounds recorded were analyzed later in the laboratory by means of a sonograph.

(*b*) *Classification of vocalizations*

All the noises regularly made by wild adult Mynas of either sex can be classified into the four main categories below:

(i) *Chip-call.* This is a very loud, very piercing, short descending squeak, and is made by all adults when excited or alarmed. The body is jerked or swivelled as the chip-call is uttered with the beak open, a movement which helps to make the caller visible. The structure, with sudden onset, is such as to assist further in locating the caller (Marler 1955 discussed the cues needed for such location), and is also well suited to being heard through the irregular 'white' noise of intermingled forest noises. Their function appears to be partly in long-range contact between individuals, and partly as an alarm call at closer range. The structure of the chip-call made by different individuals differs slightly but consistently. There are greater differences between the chip-calls of birds from different regions, and playback experiments showed that Mynas could detect these differences, responding more strongly to chip-calls recorded in their own region.

(ii) *Um-sounds.* These are soft sharp nasal 'am' noises, made almost all the time by all active birds, and apparently functioning mainly in close-range contact and co-ordination between individuals. The structure of an um-sound makes it easy to locate the caller. This sound grades in structure according to context.

(iii) *Whisper-whistles.* These are soft high-pitched sounds of repetitive structure. They are made in periods of inactivity and low arousal. Any adult Myna has a repertoire of a few discrete patterns of whisper-whistles, all of them unique to itself. Their function, if any, is unknown.

(iv) *Calls.* These are loud noises of an enormous variety of precise types: whistles, wails, shrieks, gurgles, groans, squeaks, etc. They are often low-pitched and human-like. They are made especially when Mynas see or hear others. Every adult bird possesses several such calls, of different types; they are the most characteristic and most interesting of Myna vocalizations, and were studied in the greatest detail. It is 'calls', as defined here, which are dealt with in the rest of this paper.

CALL TYPES

It was clear to the ear in the field that Myna calls were of discrete types, without intermediates. It proved possible to demonstrate this objectively by comparing sonograms of different calls; the method developed was to determine the proportionate overlap of the two patterns of sonographed calls being compared, using a tracing of one of these sonograms on transparent graph paper. Details of this 'Difference Index' method have been described elsewhere (Bertram 1970). The great value of the method lay in establishing that the differences and similarities in call types as noted by ear in the field were genuine and not purely subjective ones.

Any adult Myna was found to have a repertoire of different call types, without intermediates ; i.e. the call types of each individual were discrete. The size of the repertoire varied between individuals, ranging from 3 to 13 with a median of 8·5. Using the concept of a 99% repertoire (Bertram 1970), it proved possible to compare repertoire sizes of birds from which different numbers of calls had been observed. Males were found to have generally larger repertoires than their mates ; but males did not call significantly more or less often than did their mates. Birds with large repertoires tended both to have mates with large repertoires, and to call more often.

Some of the call types in a bird's repertoire were uttered much more frequently than others, in many cases 10 and more times as often. Birds which were heard in both years of the study were found to keep their repertoires roughly constant over that time, in size, in call types in the repertoire, and in commonness of those call types.

No bird shared any of its call types with its mate. No general differences could be found in call types made by the two sexes ; each bird certainly has the potential capability of producing its mate's call types, and certainly it has frequently heard them, yet it does not possess them in its repertoire. Its own call types are as different from one another as from those of its mate.

Recordings were made of Mynas in different regions of north-east India. No Myna shared a call type with any other from a region other than its own.

On the other hand, each Myna shared some of its call types with one of the birds in each of several near neighbouring pairs, and it was eventually determined that in each case, it was with the bird of the same sex as itself. Thus a male shared call types with several neighbouring males, and females similarly. The great majority of call types in a bird's repertoire, especially the common ones, were found to be possessed also by at least one other individual. On average, 40-50% of a bird's repertoire of call types would also be in the repertoire of a neighbour living within 2½ km of it; this proportion declined gradually with distance with the result that birds more than about 14 km apart had no call types in common with one another, yet both would share some with an intermediate individual. This is clear evidence of vocal imitation of other individuals in the wild.

Call types which were made commonly by one bird tended also to be made commonly by other birds which possessed that call type. Each call type had a limited geographical range, and tended to be scarce in the repertoire of birds possessing it at the edge of its range.

In the detailed structure of a shared call type, fine but consistent differences could be detected on sonograms and often by ear. Playback experiments (the technique of which is described later) indicated that birds could distinguish between a call made by their mate and a call of the same type made by a neighbour.

CALL TYPES PRODUCED BY MYNA PAIRS WHEN ALONE

There were few external contexts other than auditory ones which could be shown to determine or to influence the call type produced. The exception was of call types uttered when in the air ; birds occasionally called while flying (especially when chasing one another in flight), and if they did, the call type used either was a call type heard on no other occasions (i.e. purely a flight call) or was one particular other one of the call types in their repertoire.

Auditory contexts appeared to be more important ; the call type next uttered by a bird could be shown to depend both on the last call type it had made, and on the last call type its mate had made. Mynas were found to call at irregular intervals. Their calling, with calls very short compared with the intervals between them, is highly discontinuous. It was shown that birds did not produce their call types at random, but tended to order them. After a call, the next call uttered was likely either to be a repeat of that same call type, or to be a call of one or two other call types which significantly often followed the first. Some individuals tended to utter two particular call types alternately. It was found that a bird tended to produce its call types in the same order as its neighbour produced its call types, provided such call types were in the repertoires of both individuals. This is evidence of more complicated vocal imitation between individuals.

A bird also tended to standardize the call types made after each particular call type of the mate; this was especially so with 'replies', i.e. calls made within 2½ seconds of a call by the mate. 'Replies', as defined thus, occurred frequently, and tended to be of standard types which depended on the particular call type of the mate which was being replied to. These standardized call-and-reply sets tended to be the same in neighbouring pairs of birds, provided, obviously, that these neighbouring pairs possessed these call types in their repertoires. This again is evidence of vocal imitation in calling, of an even more complicated form.

CALL TYPES PRODUCED WHEN IN CONTACT WITH OTHER PAIRS

Pairs rarely met one another conveniently for me. Therefore most of the information on calling between pairs came from playback experiments. These were carried out in the following way. A single Myna call was played to a pair of Mynas from a tape-recorder on the ground about 30 m from the tree in which they were nesting and were therefore usually perched. The call was played once ; the next call would be played 1½ to 2 minutes later. The birds' responses, both physical and vocal, were noted down. Frequently the birds flew ; if they did, it was usually at once, and in the direction of the loudspeaker ; they also usually called, especially at once, and used call types dependent on the playback call type. Thus they were clearly responding to the playback call.

In experiments where playback calls of neighbours were alternated with calls of strangers from a distant region, Mynas responded more strongly to their neighbours' calls. (The measures of strength of response used were : occurrence of flight within 30 seconds; total number of calls and whisper-whistles within 1½ minutes ; time elapsing before response ; and proportion of playback calls ignored.) Nonetheless, they were definitely responding to the calls of these strangers, although such calls were of call types completely unfamiliar to them—they must have been able to recognize them as Myna calls, either by sound quality or by elimination.

In the above experiments, the calls of neighbours were of call types which were in the repertoire of the subject pair being tested. Further playback experiments showed that the stronger response found (above) to neighbours' calls was because they were familiar, not because they were in the subject pair's repertoire. After hearing a playback call, birds tended to match it, i.e. to produce at once that same call type if they possessed it in their repertoire. (This matching was also extremely noticeable when pairs of Mynas met.) That call type was then also made more frequently during the subsequent 1½ minutes, and so were those other call types which were associated with that call type in the subject pair's calling when in isolation. There were indications that the commonness of different call types in a pair's repertoire was influenced by the call types their adjacent neighbours used.

Thus the call type a bird has just heard (made by either itself, its mate, or its neighbour) influences the call type it makes next ; and since these other birds behave similarly, calls made also influence calls heard. Summarizing this and the previous section, it may be said that the more, and the more recently, a bird has made or heard a call type or sequence of call types, the more likely it is itself to produce that same call type or sequence of call types.

DISCUSSION

It appears that Mynas are able to recognize conspecifics by the quality of the calls they produce, if these calls are not of local types which are familiar to them. What aspects of vocal quality can be possessed in common by the enormous variety of different call types is not clear, and it is possible that they also rely on a method of elimination in recognizing as a Myna a stranger from an unknown region. Playback experiments showed that Mynas can recognize birds from the same locality, responding more strongly to these than to strangers ; the reason for this difference in strength of response is not clear. The sex of a neighbour is at once obvious from the call types it makes ; it is not known whether there are any cues which enable identification by voice of the sex of a stranger. Auditory recognition of individuals is clearly possible in several ways : by which call types are in the repertoire ; by the fine structure of these call types ; by whisper-whistles ; or by details of the structure of chip-calls ; the relative importance of these is not known, and nor is the extent of the need for auditory recognition of individuals.

There have been few satisfactory experimental studies demonstrating auditory recognition of individuals in other species ; those in which it has been shown to occur include Guillemots, *Uria aalge* (Tschanz 1968), Laughing Gulls, *Larus atricilla* (Beer 1969), and Common Terns, *Sterna hirundo* (Stevenson *et al.* 1970) where there was recognition of parents by offspring ; in Gannets, *Sula bassana* (White 1971) in which recognition of the voice of the mate was shown ; and in Whitethroated Sparrows, *Zonotrichia albicollis* (Falls 1969) where there was recognition of individual neighbours. There have been numerous studies showing auditory recognition of conspecifics, and in some cases (e.g. Abs 1963 ; Brémond 1967, 1968 ; and Falls 1963) it has been shown what parameters of the songs are used by the birds in such recognition.

No wild adult Myna was found to imitate another species; it is likely that they rarely if ever do so. If such vocal mimicry does occur, it would appear to be insignificant compared with the large amount of vocal imitation which has been shown to take place within the species. Why they do not mimic other species is a question which is asked only because Mynas are known to imitate in captivity ; there is no reason why they should, and their mimicry in captivity is probably equivalent to their learning calls by selective imitation of conspecifics in the wild. Such imitation of conspecifics is necessary in a bird with no innately patterned calls and apparently little or no inventiveness. The evolution of this situation will be discussed elsewhere. For the present, knowing the use of the voice by Mynas in the wild, their imitative ability in captivity is no longer inexplicable ; it is no less remarkable.

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Bird vocalizations as systems of communication[1]

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(*With eleven text-figures*)

I believe all naturalists will agree that birds are the most vocal animals apart from man. But what is all this noise for? Obviously—for communication! (Thorpe 1961). This answer at once gives rise to a second question, namely, what are the special circumstances of bird life which render vocal communication pre-eminently valuable? After all birds have outstandingly refined and perfected visual powers including excellent colour vision; they show a wide and often spectacular development of plumage, obviously adapted for display and signalling purposes. Linked with these they have evolved a complex series of elaborately and precisely controlled display movements and postures, designed to exhibit to the utmost advantage, as signalling devices, almost every feather of these specific plumage patterns: so, with all this, where does the voice come in?

Sound production, coupled with the right degree of development and specialization of the organs of hearing, has certain intrinsic advantages over other communication methods. The methods of communication employed by animals are, of course, very various. Apart from the visual signals, displays and gestures just mentioned, odour trails and the marking of territory by excreta and the secretions of special glands are all common and widespread in the mammals and the social insects. Such methods may indeed have their advantages for strictly terrestrial animals. But for the mobile and active birds, so often nesting in trees or bushes and little in contact with the ground, they have little utility. Again much sex behaviour in mammals is initiated and controlled by sensitivity to special secretions, as with the dog seeking the bitch on heat. However, birds, being mostly aterrestrial, have had no reason to develop the special secretions and high olfactory sensitivity found in mainly ground-living animals. So it is understandable that the birds should not have developed olfactory stimulation as a feature in their sex life [Thorpe, W. H., see chaps. 2, 5 and 6 in Hinde, R. A. (Ed.) 1972].

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Quite apart from the special needs of creatures which are airborne, active and largely arboreal, these above-mentioned methods of communication all have considerable general limitations compared with mechanical vibrations of a medium—especially the air—as signals. Spiders of course can obtain certain information as a result of perceiving the vibrations of the web, and rabbits signal by thumping the ground. But the great advantage of using airborne or waterborne vibrations, namely ' sound ' as signals, is that sound carries far and fast and readily bypasses obstacles. There is also a great spectrum of frequency and intensity available for use. In terms of mechanical effort, sounds are extremely economical to produce, and—since sounds vanish as quickly as they are produced—the items of information do not accumulate so as to prevent the sending of further messages. So it is obvious why a language (and after all the communication systems of birds may legitimately and in a general sense be termed a language) if it is to achieve its full potentialities must be a language of sounds. But although the language of sounds has been brought to a high degree of development by the insects, the amphibia, the mammals and perhaps also by the fish (which would be expected, because a sound wave travels farther, for a given loss of amplitude, in water than in air, and also approximately four times as fast) the birds, again apart from man, have raised the language of vocalizations to a level not otherwise attained in evolution.

Granting all this we may ask the question, ' What are the particular circumstances of avian life which render vocal communication so valuable ? ' These can be briefly listed under two headings as follows: *A*. On the nesting grounds during the breeding season. Here the communication is primarily by song or its substitute call-notes in birds which have no song. *B*. On winter or off-territory feeding grounds, on migrations and in strange or hostile environments. For these purposes it is usually the call-notes which are involved rather than the song, but there is no doubt that there are many examples (e.g. Terns) where call-notes, besides constituting a series of signals widely and perhaps innately understood throughout the species as warning calls etc., can also contain sufficient individual elaboration to render them serviceable as individual recognition marks.

Included under group *A* above, we may list the advertisement, establishment and maintenance of territory. The establishment of the pair bond. The recognition of the mate and the ability to distinguish him or her from other individuals in neighbouring territories; and also, as often seems to be the case, to distinguish between various neighbouring individuals. Then when the young are hatched and moving about, and while parental care is still operative, it is clearly often important that the young should be individually recognizable by the parents and the parents by the young. It is doubtful how far this situation obtains in the nidicolous and altricial species but there is clear evidence that in many of the nidifugous and precocial birds such individual recognition may be extremely important and may extend for a long time after the young are fully winged and active. Even though they may not require feeding, it can often be important for the young to be protected from the inclement weather, shepherded away from danger and introduced to the best feeding grounds and the most suitable types of food available in the general environment (Thorpe 1968).

Under the heading of *B* the following circumstances must be mentioned. For life during the winter and in feeding flocks, as indeed throughout the whole life-history, calls warning of predators or other dangers are perpetually required. Above all perhaps on migration is it undoubtedly valuable, on many occasions, that a flying group should keep together.

Finally there are some situations common to *A* and *B*, namely communications in darkness or bad visibility, communications in dense vegetation and communications amongst colonial nesters, especially dense colonies of sea birds, where nothing less than the great elaboration and precision of which auditory communication methods are capable is likely to provide the necessary refinement and individually recognizable multiplicity of signals.

A very significant example of the way in which call-notes are often adapted to the particular function that they serve is provided by the call-notes used by various passerine families that give warning of danger from predators. Marler (1955) has shown how such notes are specialized in their acoustic structure for the particular type of predator encountered. Thus in finches, chats, warblers, thrushes and wrens, detection of an enemy on the ground or perched in a tree (e.g. a weasel, a hawk or an owl) results in the birds giving repeated loud calls of extremely brief duration but covering a great frequency range. Call-notes of this structure usually sound more or less click-like or tick-like to our ears. They are often given in a situation in which it is presumably advantageous for the bird concerned to draw attention to this particular danger and to warn others of its exact location. Thus we get what is known as the mobbing response of many small birds to a perched owl in which they stand around at a fairly safe distance and chatter at the enemy. The result is to attract neighbours to join in the mob. Now it has been shown that this type of call has the characteristic of being very easily located—not only by bird ears but by our own; for loud click-like sounds are quickly and readily referred to the right direction and roughly to the right distance.

When however danger is from a flying predator in the air above, e.g. hawk, or an owl, then the threat is immediate and the danger great. So far from making itself conspicuous the threatened bird dives into the nearest shelter and gives a type of call which starts and stops gradually and maintains a fairly constant pitch somewhere around 7 kHz. Other birds hearing these calls likewise fly to shelter and repeat the same calls from their hiding-places. The point that first strikes the human observer on hearing these calls is that they are extremely difficult to locate. This is due in the first place to the fact that they lack the characteristics previously mentioned which make localization easy. But besides this there is another reason. A bird employs the same methods as we do to locate the origin of a sound. These consist of comparisons between the sound as received by the two ears involving three different types of data: (1) phase difference, (2) intensity difference and (3) time of arrival. Phase difference is most likely to be valuable at low frequencies: for instance, the data become ambiguous when the wavelength is much less than twice the distance apart of the ears. Intensity differences are most valuable at fairly high frequencies and the differential effect on the two ears is due to the 'sound shadow' cast by the head of the listening bird. Sound shadows only become important when the wavelength approximates to the diameter of the obstruction. Differences between the time of arrival of the sound at the two ears will, of course, be more obvious the larger the distance apart of the ears. But calculations suggest that sounds about the frequency of 7 kilohertz are likely to be maximally difficult to locate for the ears of a bird of medium size—say a hawk or an owl. This frequency is too high for effective binaural comparisons of phase difference and too low for there to be enough sound shadow perceptible by the ears. Thus the *seet* call of the male chaffinch probably gives no clues as to its location either by phase or intensity difference. This leaves only the third method, the appreciation of binaural time differences; and just because the sounds begin and end gradually or imperceptibly, no clues for time difference are supplied. So it appears that the alarm-calls of quite a number of passerine families, uttered when a predator threatens, are both physically and physiologically far more precisely adapted to their function than anyone would have supposed previous to Marler's work.

One of the most interesting results of recent studies of bird behaviour has been the discovery of the desirability, one may even say the necessity, that parents should learn to recognize their young individually and the young their parents. Even in nidifugous species, where the young move about and may scatter soon after hatching, this individual recognition is often crucial. This implies of course both individual distinctiveness and the ability to learn and respond appropriately to individual differences. Indeed when we consider the problem of reproduction and survival faced by birds such as many species of gulls, terns, gannets, penguins and so on—birds which nest in very dense colonies and obtain their food during the nesting period in rather restricted areas of sea or coastline near their colony—we can at once see a number of ways in which such abilities for individual recognition could be advantageous. Without it the feeding of the young, at least as soon as they become mobile, could be a very wasteful process. Hordes of young would be competing for food from each individual adult as it returned to the colony; with the result that the strongest, the most fortunate, the most mature or the quickest, would obtain ample food and many others would starve. And those which did survive would be no better fitted to take their place as adult members of a colony-nesting species. In the circumstances of colony nesting the eugenic need is for selection to operate so that adults which ensure that their own young are fed are at a selective advantage without, thereby, decreasing the chances of other young in the assemblage. This is the *sine qua non* of social life.

Tschanz, summarizing in 1968 nearly 10 years of work, was a pioneer in his demonstration that young guillemots (*Uria aalge*) learn to react selectively to the call of their parents and that, during the first few days of life, the parents similarly recognize their own young. Indeed there is some evidence that the young while still within the egg may learn to respond to and recognize some aspects of the sounds produced by the adults. There has long been considerable reason for suspecting that in some terns and gulls also (Beer 1970) the adults can recognize their mates and young and the young their parents, by call alone. Thorpe and his co-workers (Thorpe 1968; Hutchison, Stevenson & Thorpe 1968; and Stevenson *et al.* 1970) have studied two species of terns in this respect, the Sandwich Tern (*Sterna sandvicensis*) and the Common Tern (*Sterna hirundo*) and have found that the so-called 'fish call', uttered by the parent when returning to its young with food, has just the kind of structure required to provide auditory data for individual recognition. In the forty different individuals from which it was possible to obtain a series of samples of the 'fish call', each bird had a call measurably distinct from all the others and the successive calls given by any one bird were extraordinarily similar. Each call lasts only half a second or less but within this half-second there are three phases and each of these phases is different from the others and characteristic of the individual which gives them, in a combination of qualities. Thus we can measure independently the duration of the segment, the number of pulses in a segment, the lowest and highest frequencies displayed and the change with time in the distribution of the principal frequencies. Yet with all these individual characteristics present the 'fish call' is still a good diagnostic feature for the species. In the case of the Sandwich tern for instance it seems probable that the duration and number of pulses in the third segment are used to identify the individual's call and also that the frequency changes during the passage of the second segment contribute to this. On the other hand the first segment of the call does not show individual differences of the same degree and it is likely that the first segment is primarily of importance for indicating the species and the last two more specialized for determining the individual. And all this information is conveyed in a call lasting as I have said half a second or less and the individual segment perhaps enduring for no more than a fifth of a second. Sensitivity to changes in auditory stimulation of such extremely brief duration are of course quite beyond the capacity of the human ear. But there is now a considerable amount of evidence showing that the temporal sensitivity of the bird ear is better than ours by a factor of about ten. And indeed if we slow down tape recordings of these ' fish calls ' of the terns to about 1/4 speed we find that we can begin to distinguish these important individual differences. That the terns themselves can indeed do this has been shown by Thorpe and his co-workers (Stevenson *et al.* 1970) in the Common tern. He found that the chick at 4 days of age while quite unresponsive to a playback of calls of other members of the colony, responds immediately on being played the returning call of one of its own parents. The response is a sudden alert, ' cheeping ', turning and walking towards the loudspeaker. So it seems that the call of the returning parent, the Common tern, carrying food, is quickly learnt and responded to by the individual young concerned. If we may put this in blatantly anthropocentric terms it appears that this call is in effect saying ' Here is Mum [or here is Dad] with food '.

There is also a great deal of information available regarding the specialization of songs, as distinct from call-notes, for individual recognition. For my discussion of this I shall restrict myself to a particular case, namely that of antiphonal song or duetting as a new topic and one particularly appropriate to this volume as mainly relevant to tropical species.

I first encountered the duetting of tropical bird species on my first visit to a tropical forest environment, namely that at Barro Colorado, Panama, in 1932. There I encountered the spectacular duetting of the Marbled Guiana Quail (*Odontophorus guianensis panamensis*). I also then learnt of the duetting propensities of the tropical American wrens. A lengthy visit to Tanganyika in 1939 reinforced my interest in duetting but the time was still far too early for careful study since the tape-recorder had yet to be invented. Not until 1962, during a study visit to Uganda, did I have the opportunity to record African birds for myself, and I at once became fascinated and astonished at the constancy and precision of duetting in the genera *Laniarius*, *Cisticola*, *Cossypha* and *Trachyphonus*; and realized the possibilities of study, now for the first time opening out, as a result of the development of portable tape-recorders linked with the use of the sound spectrograph. Thus commenced a research project which was to last over 10 years (Thorpe 1972). As a result of my own work and of a survey of the now extensive literature I can state that there are 32 or more families of birds in which duetting—

that is either simultaneous or alternating song—is known to occur between the mated males and females. Within these families there are something of the order of 120 species which have been noted as duettists in this sense and of these 120 nearly 100 are tropical. In fact precise duetting or antiphonal singing as a means of maintaining contact between male and female is extremely rare outside the tropics.

Of the 32 families mentioned there are some 9 in which antiphonal song at its highest development has been produced. By this we mean alternating or precise unison song between the paired male and female given with high precision and used even when the birds cannot see each other. The result of this is that distance, intervening vegetation etc., offer little or no obstacle to mutual recognition and the maintenance of contact. These 9 families are: Megapodidae, Phasianidae, Rallidae, Formicariidae, Troglodytidae, Turdidae, Sylviidae, Laniidae and Meliphagidae. It soon became clear that the most attractive African genus with which to begin work was *Laniarius* and *L. aethiopicus* the most promising species for our purpose. Accordingly the brief summary which I shall give here concerns this species almost exclusively. Before proceeding further however, one point should be made: that is that the term duetting includes four varieties of dual song namely, (*a*) antiphonal, (*b*) polyphonic, (*c*) unison and (*d*) overlapping (polyphonic). These four examples are illustrated by Fig. 1. Three separate populations of the race *major* of this species were studied in East Africa, two of them in Kenya separated by about 240 km and one in SW. Uganda separated from the nearest Kenya population studied by about 700 km. Vocalizations consist of antiphonal singing between the members of the mated pair, the male usually, but not necessarily, being the leader. On occasion the birds may sing the whole of a given pattern in exact synchronicity. We also found that either bird alone can sing the whole duet pattern by itself. As Figs. 2-8 will show, these song duets comprise attractive little tunes, even striking the European listener as of considerable musical quality with a clear harmonic relationship. The device of one bird singing the whole duet pattern by itself when the other happens to be

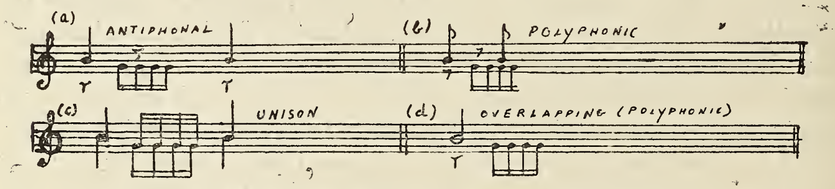


FIG. 1. Types of duet singing. [N.B.—The contributions of the two birds are distinguished by the notes of one having the tails up and the other down. Thus in (*c*) where all the notes are shared each note has two tails, one up the other down.]

absent, seems to be used as a means of calling an absent mate back to his or her territory. It was also shown that while there are many duet patterns common to most, if not all, pairs in a given area, the repertoire of each pair is likely to be distinct from that of its neighbours and the individual repertoire and to some extent also the individual voice quality can be used as a means of individual recognition by the birds. The vocal repertoire is worked out and developed between the two members of a mated pair and isolated birds seem unable to produce any complexity of vocalization patterns. Studies of captive birds have shown that the

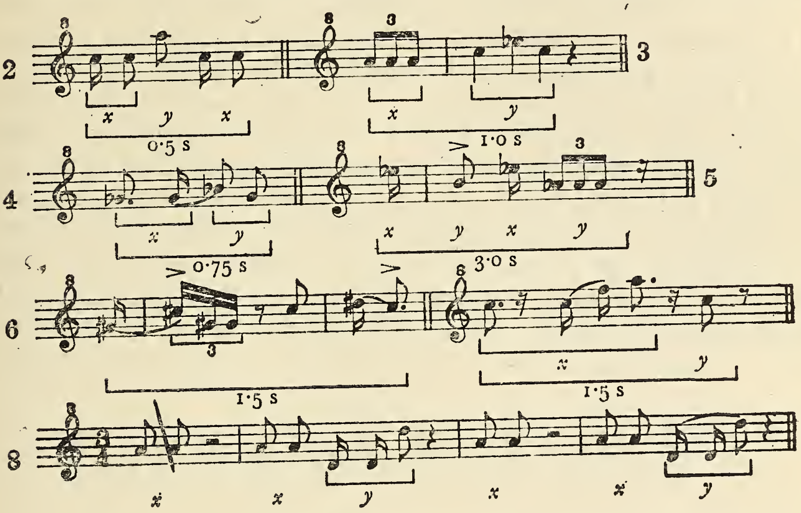


FIG. 2. *Laniarius aethiopicus sublacteus*, Vipingo, Kilifi, Kenya, Dec. 1954. N.B.—All the illustrations are given at approximately scientific pitch (middle 'C'=256 c/s). Unless otherwise stated, as here, all the figures refer to race *major* (Thorpe & North 1965). N.B.—The figure 8 above the treble clef symbol indicates that all that follows should be read as one octave higher than would otherwise be the case, e.g. middle 'C' becomes 512 c/s. '*x*' & '*y*'=the two birds.

FIG. 3. *L. aethiopicus*, Dundori, Nakuru, Kenya, 17 Mar. 1964 (Thorpe & North 1965).

FIG. 4. *L. aethiopicus*, Kabale, Uganda, 15 Feb. 1962 (Thorpe & North 1965).

FIG. 5. *L. aethiopicus*, Meadow Point, Lake Nakuru, Kenya, 17 Mar. 1964 (Thorpe & North 1965).

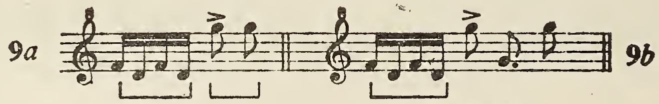
FIG. 6. *L. aethiopicus*, Hippo Pool, Lake Nakuru, Kenya, 17 Mar. 1964. Note that this is a rather more elaborate duet than the previous ones. The contribution of the two birds is not indicated in this case since it seemed to vary a good deal (Thorpe & North 1965).

FIG. 7. *L. aethiopicus mossambicus*, San Martino, Mozambique Coast (C. Haagner). The timing in this example is very precise but the bar length might vary between 0·75 and 1·5s (Thorpe & North 1965).

FIG. 8. *L. aethiopicus mossambicus*, San Martino, Mozambique Coast (C. Haagner). This is a duet with a more complex time pattern. Bar length 1·5s (Thorpe & North 1965).

crowding of the birds, particularly if they cannot see one another, leads to great temporary elaboration of duet patterns ; and there is some evidence that in crowded areas where territories are small, duet patterns are more complex than in regions where the population is sparser.

The functions of antiphonal song in this species seem to be (1) location and maintenance of contact with mate ; (2) mutual stimulation between the two birds of a pair, as a part of, or substitute for the ordinary methods of visual display ; (3) aggressive maintenance of territory and (4) mutual reassurance after disturbance. During the course of this study on the Kenya research areas we not infrequently encountered cases of trio singing and occasionally of quartet singing. Both of these may, I think, result from aggressive encounters between mated pairs at territorial boundaries and it seems likely that trio singing commonly takes place between a mated pair and a well-grown young one. Figs. 2-8 show a variety of characteristic duets made by three different subspecies of *Laniarius aethiopicus* and Figs. 9 and 10 show two remarkable examples of trio singing in the field. Vocalizations of this species were of course studied by the usual methods of physical analysis using a sound spectrograph but since the notes of which the duets are composed are so pure and precisely pitched ordinary musical notation gives a much better and equally accurate picture of the songs than does the sound spectrograph and is accordingly used here.



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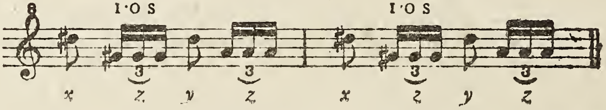


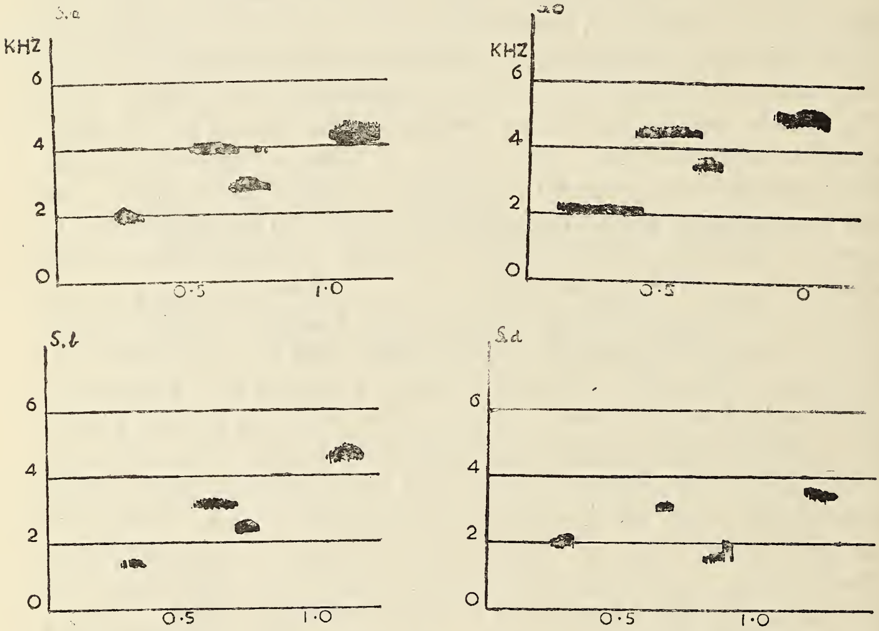
FIG. 9 (*a*, *b*). *L. aethiopicus*, Lake Bunyoni, Kabale, Uganda, 14 Feb. 1962. *a*, represents a duet pattern heard as a very long, precisely timed series. During one considerable stretch of this series a third bird '*z*' joined in. It was far away from the others but nevertheless inserted its single note remarkably accurately. *b*, it tended to intervene in every second duet of '*x*' and '*y*' (Thorpe & North 1965).

FIG. 10. *L. aethiopicus*, Dundori, Nakuru, Kenya, 3 Apr. 1964. A remarkable trio. All three birds were in the same tree. Note that bird '*x*' gave a D sharp every 2 s and bird '*y*' a D sharp every other 2 s whilst bird '*z*' gave a G sharp and an A natural every other 2 s in alternation (Thorpe & North 1965).

In addition to studies in the field on this species and others also studied during a period of four years in large tropical aviaries at Madingley, Cambridge, England, this work confirmed the field observations that the birds have exact control of the timing, pitch and overall rate at which they produce their duets. The pitch control is certainly accurate to a semitone and often consistent to a quarter-tone; although whether the Shrikes 'deliberately' control their pitch to this degree of fineness is not absolutely clear. Work in aviaries and in some simple separation experiments confirm the view arrived at from field work that one of the major functions of the imitative ability of the birds is to establish and strengthen the social bonds. It also suggests that social antiphonal singing is in the nature of a mutual display which serves to maintain cohesion and ensure recognition. The possibility that a duet phrase could be used as a personal 'name' by one bird for another prompted us to carry out separation experiments with paired birds. These confirmed the view that it is the male who normally initiates the duets and when a duet is started by a female her note is usually an unmusical snarl. This may be because the male usually hesitates about answering female notes other than the snarl. It seems that new duets are particularly likely to be initiated by the female if the response of the male is for any cause unpredictable or illtimed. The results of these experiments can be briefly summarized as follows: (1) separation leads to an increase in the total vocalization of the bird left in the territory. (2) The bird moved to a new territory tends to decrease its vocalization. (3) The bird remaining in the territory, if it is a male, employs all its usual vocalizations and may employ some of those of the missing partner in addition. (4) An isolated male will answer a playback of his mate's voice with the appropriate item of his repertoire but he is much less likely to respond to a playback of his own voice; and if he does so at all it will only be with the item played. (5) The female left in the aviary will answer those notes of her own male which she may be able to hear, but will not answer the notes of any neighbouring pairs. (6) A male kept in association with a duetting pair was never heard to vocalize until the resident male was removed; when it became clear that he had, at least in part, learned his rival's repertoire, although he had never been heard to produce it before. The remaining female would respond to this though she would not respond to strangers.

Thus the overall picture shows that these duet patterns are worked out between members of a mated pair as soon as their formation is established and that the repertoire of any one pair, while it will certainly include a number of vocal patterns which are common to other pairs in the district or other districts, is nevertheless sufficiently individual to the pair concerned to render its recognition by voice alone quite simple. Thus antiphonal singing seems to be fully explicable as a highly effective method for maintaining contact between known individuals in an environment of dense vegetation.

In conclusion it is illuminating to consider the situation amongst the 40 species and 153 subspecies of the genus *Cisticola* (Grass warblers). Out of this great assemblage the superspecies *Cisticola hunteri*, comprising four species, contains the only ones for which there is as yet evidence for antiphonal singing. It seems likely that these four, *hunteri*, *chubbi*, *nigriloris* and *discolor* are duettists, although there is no firm evidence concerning the last of them. They are all birds of dense grass vegetation above an altitude of 1500 metres ; ascending in one case to over 4300 metres. The songs are normally a duet, presumably started by the male ; but trio singing, quartet singing and elaborate communal singing among pairs are well established in one species and probable in the others. There is evidence for both individual and geographical differentiation between song patterns and the accuracy of timing is on occasion phenomenal. In one instance with *Cisticola chubbi*, the mean reaction time of approximately 400 millisecs was consistently maintained to a standard deviation of around 3 millisecs : that is about 1/8 of the error which a human being would show under similar circumstances (Thorpe 1963). The speed and precision of the response timing is almost as impressive as this in some of the Shrikes including *Laniarius aethiopicus* and particularly the superspecies *Laniarius barbarus*. *L. barbarus* and *L. erythrogaster* have been particularly carefully studied in this respect,



Vertical scale : kilohertz
Horizontal scale : Time in seconds

Fig. 11. Traced sonograms showing only the musical tones in the duets of *Cisticola nigriloris* and their transposition. S.a, S.b, S.c, and S.d are four duets recorded from a single pair by Stjernstedt. a, b, c & d. Consistent pitch patterning with transposition in the Mbeya Mountain pair (Thorpe 1972).

the second species by ourselves in tropical aviaries as well as in the field (Thorpe 1972). But to return to *Cisticola*, while the function of multiple singing is not understood there is good evidence that individual recognition can be based on vocal characteristics. It is suggested that at the high altitudes in which these birds are found, persistence of dense mist and cloud may well be responsible for the survival value of well developed vocal communications. Fig. 11 (Thorpe 1972) shows another intriguing characteristic of the songs of *Cisticola nigriloris* where the pitch patterning is highly precise but has, an unusual feature of bird songs, a precise transposition in the middle of the song.

In conclusion it may be said that although a great deal has been learned about antiphonal song in recent years it is clear that a vast number of further examples wait to be elucidated and that they are most likely to be found in inhabitants of tropical vegetation.

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The Asian Honeyguides[1]

HERBERT FRIEDMANN*

Our overall knowledge of the honeyguides has grown considerably since my 1955 monograph, as is evidenced by the fact that we now recognize 17 species as against 11 at the time that publication was issued, by the fact that we know more about the nature of wax digestion by some of the African species, and by our considerable accumulation of additional data on the choice and relative frequency of brood host selection by a number of African honeyguides. However, this does not necessarily mean that our information about the ethology of all the members of this fascinating group of birds has advanced accordingly. The two Asian species of the family, as well as many of the African ones, unfortunately have remained quite unstudied in the field, and are still known primarily as ' museum species ' rather than as living organisms. I fully realize the great difficulties involved in studying them in life, but I would like to emphasize the importance, even the critical importance, of furthering and deepening our knowledge and understanding of the two geographically ' remote ' members of this remarkable, and otherwise African, avian family. One cannot help but want to know more about the two species of honeyguides found in Asia, so far from the rest of their relatives ; to know whether they present similar or divergent ethological patterns ; whether either or both of them show anything comparable to the so-called ' guiding behaviour ' of the African greater honeyguide (very inconclusive evidence seems to suggest they do not, but this is uncertain) ; whether they are brood parasites (it would be most unlikely if they are not, but this remains to be learned) ; whether either or both have mandibular as well as maxillary egg teeth when hatched. Questions like these are far easier to ask than to answer, but they are worth making the necessary effort to solve. This paper will have served its purpose if it may help to induce local observers in Asia to make special and concerted efforts to fill in any of these gaps in our knowledge of these birds.

When we consider the almost complete absence of biological information still available about the two Asian honeyguides, the Himalayan *Indicator xanthonotus*, and the Malayan *Indicator archipelagicus*, it is surprising, indeed, it is historically ironical, that of all the species in the family, it was one of these, the Himalayan honeyguide, that was actually

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[1] Received March 1972.

* Dedicated to Sálim Ali, the foremost ornithologist of India, on the occasion of his seventy-fifth birthday.

the very first one of the whole group to be written about, even though the authors involved had never seen it, had no idea what it really looked like, and were led to mention it only because they had heard of its cerophagous, or wax-eating, habit. This was more than seventeen centuries ago, at a time when none of the African species were even known to what we like to term 'civilized' man. This extremely early awareness of this bird, the only member of its family to occur in India, has probably been overlooked by most current naturalists, as its recounting is buried in my monograph, referred to above. For this reason it may be well to state again the original 'source material' of this precocious knowledge.

While assembling data for my 1955 book, I mentioned to my late friend, Austin H. Clark, my disappointment in the lack of published field notes on this honeyguide. At his suggestion, as a most unpromising 'last resource' measure, we decided to search in the libraries to see if, by some remote chance, there might be anything on record about the use of bees-wax in Asia that might yield any adventitious crumbs of information about the only birds in that continent that share with man an interest in this substance. We already knew that bees-wax was a prized article of commerce in ancient times ; it was used for the treatment of dysentery, for wounds and fractures. During the all too frequent recurrences of famine, men ate bees-wax and thought it helped to assuage their hunger, and they added to this dubiously nutritious programme the thought that by eating bee-comb they would also slow up the advent of senility.

In this search we were fortunate beyond our expectations, and we did find an old account that could only be connected with the Himalayan honeyguide. Our clue to this early mention of the bird was found in Read's 1941 book on old Chinese materia medica. In the section on bees-wax, therein classed as one of the 'insect drugs', Read wrote that in the *Po-wu-chih*, a compendium of information of all sorts originally amassed by Chang Hua in the Chin Dynasty, in the latter part of the third century (of the Christian era) it was stated that the bees-wax from wild bees' nests was very much in demand and was highly prized in China at that time, and that it came from the remote glens and solitary ridges of the high mountains to the south, obviously the Himalayas. Chang Hua's manuscript account appears to have been gathered from the reports of traders and travellers who informed him that the places where the wild bees' nests are found are all on steep cliffs which cannot be scaled, and that to reach them in order to gather the wax as well as the honey, people have to go to the tops of the mountains and then are lowered over the precipices in baskets on long ropes. The important point for our present interest is that Chang Hua goes on to state that when the bees go away and leave the wax comb on the rocks, flocks of sparrow-like birds called *ling ch'ueh* or tits, also called *mi mu*, blackish in colour, come and peck it nearly all away. These birds are said to be found '... in the south, where in the first lunar month they go to mountain cliffs to find a quiet place,' and where there are bees. It appears, from this account, that the local Chinese workers who were involved as wax gatherers had to compete with these unknown, undescribed birds, which were undoubtedly Himalayan honeyguides.

According to Wylie (1922) the *Po-wu-chih* was apparently lost during the Sung period, and the work as we now know it was painstakingly reassembled from bits and pieces of it that had been preserved in a number of other Chinese compendia. The resulting reassemblage was completed in the mid years of the twelfth century by Lé Shih, in ten books under the title *Suh-pô-wûh-ché*.

An earlier, great 80-volume encyclopedic treatise on all sorts of information, the *T'ai-ping-yu-lan*, compiled by imperial command by Li Fang and his staff, was completed in the year 983. In this work there is a fuller version of Chang Hua's account of seven centuries earlier, kindly translated for me by the late Archibald G. Wenley, as follows:

> It also says in many distant countries there are secluded places in the mountain districts which produce bees wax. These bees wax places are all abrupt cliffs and rock walls which are unclimbable, and only by raising baskets to the top of the mountain and lowering them to the bottom is it obtained. When the bees leave not to return, the surplus hives and wax are unlimited. There is a small bird in shape as a sparrow. It comes in flocks of thousands to peck at it. By spring it is all used up and the place is as if it had been scrubbed and washed. In spring the bees all return to the clean place just as before. Year by year it is like this without any confusion. People also note these smooth places. They call them [the birds] wax honey birds, and call them spiritual sparrows (because) they are entirely unable to catch them .... It was added that in the spring the bees return and store up honey as before, either in the surviving combs of the previous season or in newly constructed ones. The people protect these places, which they call 'honey preserves'.

The Himalayan honeyguide is the only bird in the area known to eat bee-comb, and there can be no question but that it is the same as the 'wax-honey bird' or 'spiritual sparrow' of Li Fang's encyclopedia. The large size of the flocks reported is undoubtedly an exaggeration, and is an item that need not really bother us; it is the kind of error that easily could creep into a compiled work written by scholars who had no personal experience with the actual situation in a very remote region, and who, quite understandably, were tempted to embellish their account with such dramatic statements.

As I wrote in my 1955 book, '... it follows that 1,700 years ago the Chinese scholars had heard of the wax-eating habit of a bird they had never seen for themselves, a bird that remained unknown to the Western World for nearly 16 centuries longer, and of whose wax-eating habits we have only become aware in the last few years. There is even a curious parallel between the old Chinese appellation 'spiritual sparrow' and Hume's subgeneric one, *Pseudofringilla*, proposed for this bird some 30 years after Blyth first made it known . . .' to science.

The first corroboration by a modern collector naturalist of the habits of the Himalayan honeyguide was made in Garhwal in the 1940's by Walter Koelz, who kindly sent his notes to me for inclusion in my 1955 book. He noted that swarms of bees built their exposed combs on the vertical surfaces of high cliffs. '. . . The honeyguides would perch in the trees and then fly to the cliffs where they often clung like woodpeckers and pecked at the wax. Sometimes they would be within a few feet of the bees, of which they seemed wary and afraid . . . . Gizzards of a dozen or so specimens collected all contained bees-wax . . . .'

That the bird is subject to seasonal wandering altitudinally, if not to extensive geographic migration, in Nepal, was suggested by Ripley (1950, p. 376), thus corroborating the ancient inference of seasonality in the birds' presence and activity around the 'bee cliffs'.

Alerted to the problem of the Himalayan honeyguide by earlier correspondence, Fleming (1964, p. 523) made special inquiries about it from his local assistants in Nepal. He found that in the spring of the year the bees left their usual wintering areas to go to their 'hidden ravines' in the remote mountain gorges. At Bigu (6,000 feet) his head mantold him, '. . . . that his men went once a year to get honey from cliffs about three miles away and that he would send his man the next day to show us the place. Sagar Rana, of our party, found the location. When he scrambled down to the overhanging cliff above a stream, he saw a bird, apparently standing on its head, pecking at the remains of a bees' comb. It proved to be a honeyguide whose stomach was crammed with wax.

'We visited the place again and waited for ten minutes but saw no movement. Then Sagar made out a bird, like a small barbet, sitting on a dead branch about a foot or two from the face of the rock near where bees were flying in and out. It was another honeyguide . . . .'

Fleming's observations bear out the old Chinese account surprisingly closely. Even his noting the bird feeding upside down confirms the ancient parallel to a titmouse, which often feeds in this position. Fleming wrote me at the time that all the ancient Chinese authors had reported was quite in keeping with what he had seen.

The Himalayan honeyguide is known only from the highlands, at elevations of from 5,000 to over 9,000 feet, from near the Afghanistan border, east along the Himalayas across Garhwal, Nepal, Bhutan and Nagaland to the Myitkyina District of northern Burma. It is the only honeyguide to have such an exclusively altitudinal range, especially now that the African *Indicator pumilio* has been found to descend from its originally thought similarly high habitat to much lower altitudes. The other Asian species, *Indicator archipelagicus*, is a lowland bird of a distant region—Malaya, Siam, Borneo and Sumatra, at altitudes from sea level to 3,000 feet. Obviously, the two never come in contact, and, indeed, they seem less related to each other than each does to some of the African species. This fact, in itself, adds much interest to them as extreme examples of geographic isolates, and increases our desire to know more about them as living entities.

The presence of a honeyguide (*Indicator archipelagicus*) in southeastern Asia presents no surprisingly different, or unique, zoogeographic fact as there are numerous instances of faunal elements common to the wooded areas of southern Asia and of Africa. But the presence of another species (*Indicator xanthonotus*) in the Himalayan highlands has no such parallel. Its existence there poses a puzzling problem, unfortunately a problem to the answer of which we have no suggestive clues as yet.

Our understanding, or, more accurately, our attempted interpretation, of the phylogeny of the two Asian species is, of course, only hypothetical, but there is no reason to change the diagram of their relationships to the rest of the family proposed in my 1955 book (p. 10) ; the Himalayan species seems more nearly related to the subgenus *Melignothes*, the Malayan one to the subgenus *Indicator.* We have no way of estimating even approximately how long they have been in existence. One thing is clear about them ; their respective stocks have not been involved in parallel speciation as has been the case in some of the African honeyguides. This suggests (but does not prove) that in the habitats of each of the two Asian species there was not ecological ' room ' for more than a single kind of honeyguide. It is not at all obvious why this should be so, as in Africa we find numerous instances of sympatric existence of two or more *Indicator* species of similar habits.

In a family noted for very limited phenotypic potential, the Himalayan honeyguide is an outstandingly aberrant development. In the course of its existence it has become geographically differentiated into three subspecies, whose distinguishing differences are only slight. The Malayan honeyguide has no currently recognized races. It might be more accurate to say that until sufficient specimen material of the latter from various parts of its discontinuous, and, hence, suspiciously expedient, range becomes available for study, this honeyguide has not been found to be divisible into races, although attempts have been made in the past to distinguish an island race and a mainland one.

The Himalayan *Indicator xanthonotus* is unique in its coloration, being the only member of the entire family with patches of bright colour—orange to orange-yellow on the lower back and rump, less intense but still bright, orange yellow on the forehead and cheeks. The large bright area on the lower back is, it is true, largely concealed by the folded wings when the bird is at rest, but it must show up as a brilliant ' sign ' or ' beacon ' when the bird takes flight again. One cannot help but wonder what, if any, adaptive purpose this surprising colouristic signal may serve. Because the bird is so aberrant in its appearance, it is intriguing to speculate whether or not it has, along with its odd coloration, any as yet unsuspected ethological specialization. This is a question that only prolonged and careful field observation can answer. Nothing in the known habits of any of the plain-coloured African species gives even the slightest suggestion as to what purpose such adaptation might be directed. It is, of course, possible that it serves no purpose other than as a communicating visual ' flash ' to others of its own kind, or as a colouristic ' lure ', which by its sudden disappearance when the bird comes to rest, may serve to bewilder possible pursuing predators. The orange rump patch of the Himalayan honeyguide may thus be comparable in its function to the red or yellow rumps of some of the small barbets of the genus *Pogoniulus*, or to the white rump patch of the semiterrestrial woodpecker, the flicker of North America, *Colaptes auratus*. The fact remains, however, that so far we simply do not know, and it would be most interesting to learn more about it. It is true that two other species of the same genus, *Indicator indicator* of Africa, and *Indicator archipelagicus* of southeastern Asia, have a little band of yellow on the ' shoulders ', i.e. on the lesser upper wing coverts, but this colour is not very bright in hue, and is usually wholly or at least partly concealed in the folded wing when the bird is at rest, and is hardly visible when in flight.

In its bill structure, rather small and decidedly stubby, the Himalayan bird agrees most closely with some of the African small-billed species of *Indicator*, the group formerly called the subgenus *Melignothes*, including such drab, plain-coloured birds as *minor*, *conirostris*, *exilis*, *pumilio*, *meliphilus*, and *narokensis*, none of which flaunt even a trace of the bright colours of *xanthonotus*. The Malayan honeyguide, *Indicator archipelagicus*, on the other hand, has a larger bill, and agrees in this respect with the African greater honeyguide, *Indicator indicator*, to the female plumage of which it bears much resemblance. In its call notes it appears, from descriptions, to be similar to the scaly-throated honeyguide, *Indicator variegatus*, another similarly large-billed species. While the Himalayan honeyguide is strikingly different in appearance from all its relatives, the Malayan is not ; it is obviously a distinct species, but fits very well into the overall picture of its subgenus.

We know, from stomach contents of individuals collected as specimens, that both the Malayan and the Himalayan honeyguides regularly consume quantities of bee-comb. We also know that the wax-breaking bacterium, *Micrococcus cerolyticus*, that enables the African *Indicator minor* and *Indicator indicator* to break down bees-wax and render it at least partly digestible, also occurs in Borneo in the range of *Indicator archipelagicus*. It seems safe to assume that this same microbe is involved in the metabolism of bees-wax in this honeyguide as well. The *Micrococcus* is a soil bacterium that is absorbed together with soil-derived nourishment into the roots of the plants and thence into their flowers, where it is inadvertently acquired by the bees, which, in turn, equally inadvertently, transfer it to their hives where the honeyguides get it when eating the bee-comb. To date no one has made a search for this microbe in the Himalayan habitat of *Indicator xanthonotus*. Consequently we cannot say if it or another bacterium, ingested along with the wild bee-comb into the alimentary tract of that bird, is similarly operative in its nutritional metabolism.

Information about all parts of the life-history of each of the two Asian honeyguides would be most welcome, not only for our knowledge of these species but to help to complete and to formulate more meaningfully our concepts of the whole family. In the case of the Malayan species there is little reason to expect anything very different from what we know of some of the African *Indicators*, but in the case of the Himalayan one the unknown seems more intriguing because we do not know what we may anticipate. The recent (1970) summary of the little that we know of this bird, by Ali and Ripley, is a useful starting point for further investigation. I know of no bird in the entire Indian fauna that offers a more alluring prospect to the field student.

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Present distribution and population status of the Great Bustard, *Otis tarda* Linnaeus[1]

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(*With three maps*)

In 1969 Dr Sálim Ali drew attention to the rapid reduction in numbers of the population of the Great Indian Bustard (*Choriotis nigriceps*). In his report made at the XIth Technical Meeting of the International Union for Conservation of Nature and Natural Resources held in Delhi he expressed his anxiety about the future of this valuable species. Sálim Ali is quite right in considering direct persecution by hunters and the disappearance of its main habitats to be the main causes of the disastrous reduction in the Indian Bustard population.

The report was quite a timely one, as there are reasons to be anxious not only about the future of the Great Indian Bustard, but about the future of many other species of European, Asian and African bustards as well. In this connexion I should like to present some information concerning the present distribution and numbers of the Euroasiatic Great Bustard (*Otis tarda*), whose population tends to decrease.

The bustard is a bird of open landscapes, mostly inhabiting steppe and forest-steppe. In semi-desert bustards are found rather seldom, and are not numerous there. One may suppose that the northern limit of distribution of the European Bustard *Otis tarda tarda* Linnaeus lay on the southern boundary of the forest zone in the pre-agricultural period. In forest-steppe, strips of Bustard range protruded far to the north, while in some patches of insular forest-steppe (e.g. in the Middle Volga and in the Ural Foreland[2] areas) it formed separate patches. Due to forest felling and the extension of the areas under pasture, hay meadows, and the plough, the bustard moved to the north into the forest zone. Unfortunately, one cannot find in any publication exact data concerning the time and rate of extension of the bustard's range.

In Western and Central Europe this process seems to have taken place somewhat earlier than in the European part of the USSR. In western and central Europe forests had been cut and replaced by vast areas of heathland as early as in the Middle Ages. According to Gesner's evidence (1555), in England bustards appeared in the 16th century, pro-

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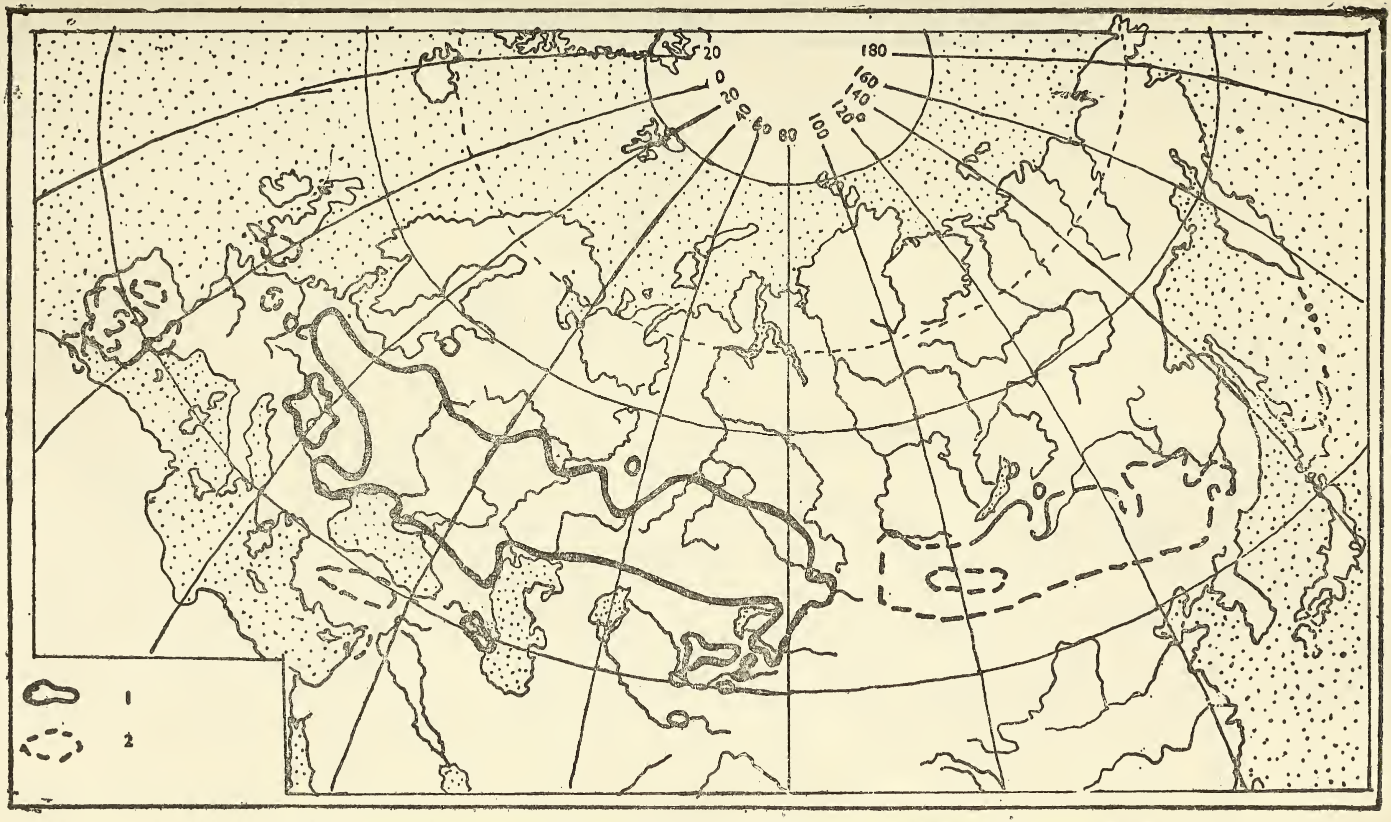
[1] Received April 1973.

[2] The Ural Foreland is the low-lying land (not foothills) west of the Urals.

bably due to the development of sheep breeding and the rapid extension of pasture. In the German-Polish lowlands bustards appeared not later than at the beginning of the 18th century, since as early as in 1751 they were found throughout the Potsdam area, though they had not been found there before (Schalow 1919). Probably at the same period the bustard appeared in the Vistula regions of Poland (Linnaeus 1758), and then in the adjoining areas of Byelorussia, around Grodno and Brest. In the 18th century bustards inhabited the eastern part of the Baltic Hills, including the Kaliningrad region (Tischler 1941), and then passed to the southern, most densely populated part of Latvia (Fischer 1778). Throughout the territory bustards inhabited mainly dry watersheds which had previously been under mixed pine-broadleaved forests and where heathlands, which are very favourable for bustards, had appeared after felling. In France, bustards were breeding in Champagne at that time, in the regions that had formerly been under broadleaved forest, predominantly oak.

The end of the 18th century is considered to be the period of maximum extension of the range of the bustard in Europe and probably the period when its population was the highest. At that time bustards inhabited many areas of the Russian Plain which had been under forest not so long before. They had their breeding sites on the territories of Minsk, Gomel, Chernigov, Bryansk and Orel regions, as well as in some areas of Ryazan and Gorki regions, in the Chuvash and the Tatar Autonomous Republics and even in the western part of the Sverdlovsk region (Kirikov 1959, 1966). It is interesting to note that the bustard area did not extend behind the Urals in that period. In West Siberia bustards never bred north of the forest-steppe zone, because farming only penetrated along the river valleys, and did not change the landscape fundamentally. In Eastern Asia bustards began to inhabit the forest zone much later. In Map 1, the borders of the breeding area of the species in the period of its maximum extension are outlined. The borders cannot be assigned to any definite period, as the extension of the species area in the east coincided with its reduction in the west.

The way in which the landscape was changed by man, causing an increase in numbers and affecting the distribution of bustards, may be illustrated by data concerning several areas of the Russian Plain situated in different natural zones. It is seen from Table 1 that as early as in the first half of the 18th century open landscapes occupied more than 50% of the whole forest-steppe area. In the area of broadleaved and coniferous and broadleaved forest such conditions were established only in the middle of the 19th century (Tsvetkov 1957). The decrease of forest areas and their replacement by agricultural lands appeared to be favourable for bustards. They began breeding in the fields, especially in those which alternated with fallow lands and pastures.


20
0
20
40
60
80
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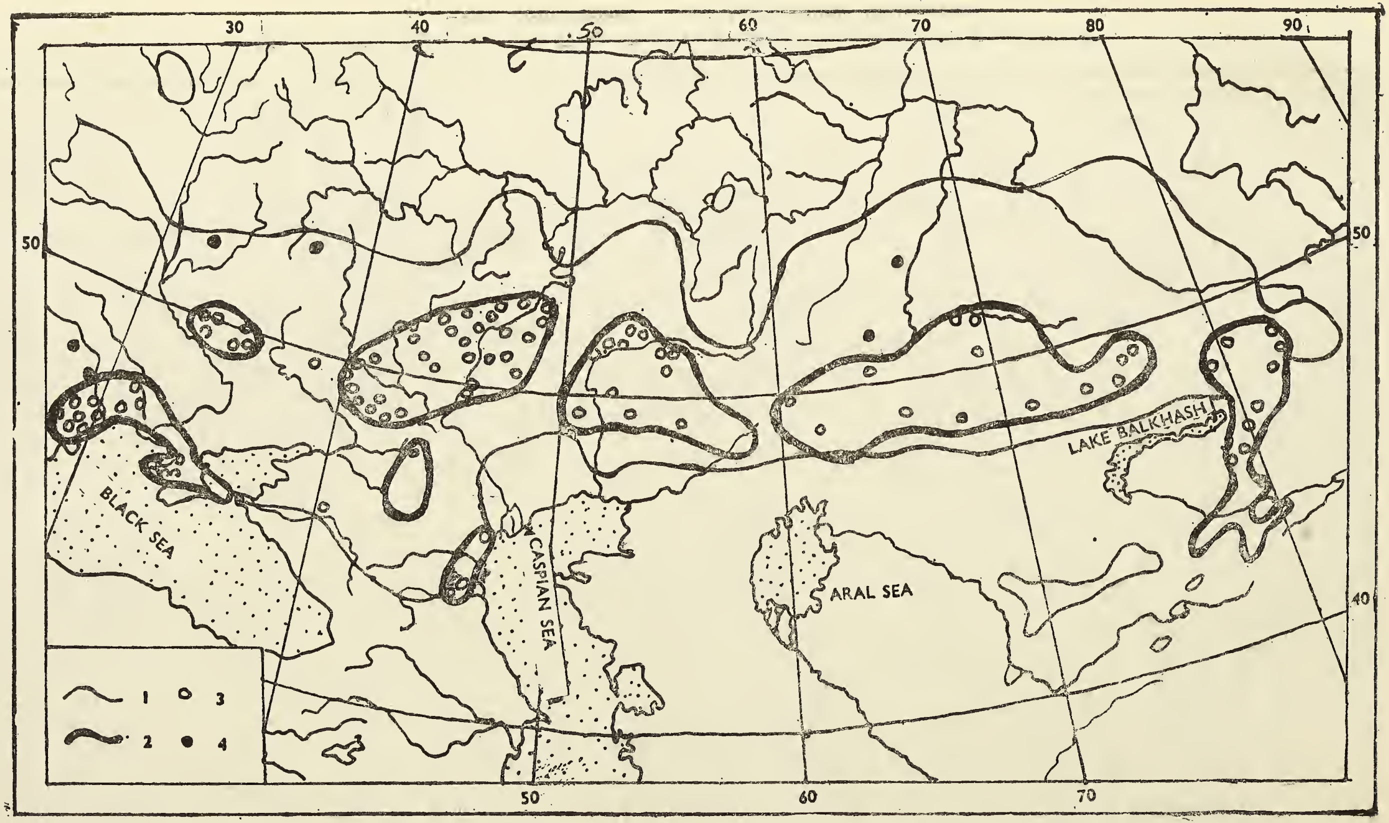
120°
140
160
180
1
2

Map 1. Distribution of the Great Bustard at the time of its maximal expansion
1. Exact boundaries; 2. Approximate boundaries.


30
40
50
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70
80
90
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40
50
60
70
BLACK SEA
CASPIAN SEA
ARAL SEA
LAKE BALKHASH
1
2
3
4

Map 2. Past and present distribution of *Otis tarda tarda* in the USSR.

1. Area at time of maximal expansion.
2. Present distribution.
3. Specific breeding areas.
4. Isolated breeding areas.

TABLE 1

LAND CULTIVATION IN THE EUROPEAN PART OF THE USSR IN THE 18TH AND 19TH CENTURIES (INCREASE IN THE PERCENTAGE OF AREA UNDER OPEN LANDSCAPES : ARABLE LANDS, HAY MEADOWS, AND PASTURES)

Region	Natural conditions	1696	1725	1795	1861	1887
Saratov, Ulyanovsk, and Kuibyshev	Steppe and forest-steppe	70·8	71·5	73·2	—	77·2
Kharkov	Forest-steppe and steppe	40·7	49·5	69·3	75·5	83·7
Tambov	Forest–steppe	49·5	53·4	63·1	71·5	77·7
Volynsk (W. Ukraine)	Broadleaved forests	—	—	37·4	45·3	65·1
Grodno	Spruce-broadleaved forest	—	—	37·8	50·3	63·6
South Latvia	Broadleaved-coniferous forests	—	19·1	21·2	33·0	60·4

In the second half of the 18th century the way in which the landscape was changed by man was somewhat different. The expansion of the area under arable land was followed by the reduction of the area under natural and semi-natural grass communities, i.e. steppes and dry meadows. This process was extremely intensive at the end of the 19th century (Table 2), its consequences being unfavourable for bustards, especially in the period of reproduction.

TABLE 2

CHANGE IN THE AREA UNDER NATURAL AND SEMINATURAL STEPPE LANDS IN THE 18TH AND 19TH CENTURIES (REDUCTION OF THE PERCENTAGE OF AREA UNDER PASTURES AND HAY MEADOWS ON ACCOUNT OF INCREASE OF ARABLE LAND)

Region	Natural conditions	1696	1725	1795	1861	1887
Tambov	Forest-steppe	31·6	30·1	25·5	13·5	13·8
Kharkov	Forest-steppe and steppe	21·7	23·2	27·3	29·8	12·6
Saratov, Ulyanovsk, Kuibyshev	Steppe and forest-steppe	62·6	54·7	36·8	24·6	23·9

TABLE 3

HISTORICAL CHANGES IN DISTRIBUTION OF THE EUROPEAN GREAT BUSTARD (*Otis tarda tarda* L.) IN VARIOUS ZONAL LANDSCAPES IN THE USSR

Regions, Territories, Republics	Sage brush and bunch-grass steppe	Bunch-grass steppe	Herb and bunch-grass steppe	Forest steppe	Broadleaved forest	Coniferous and Broad-leaved forest	Broadleaved and Coniferous forest
Volgograd*, Aktyubinsk, Uralsk, Karaganda, Semipalatinsk	xxx	xxx	.	.	.	.	.
Odessa, Crimea, Saratov	.	xxx	xxx	.	.	.	.
Kalmykija, Turgay, Taldy-Kurgan	xx	xx	.	.	.	.	.
Daghestan, Checheno-Ingushetia, Kustanay	xx	xx	xx	.	.	.	.
Nikolayev, Rostov, Krasnodar, Orenburg, Tselinograd†	.	xx	xx	.	.	.	.
Poltava, Voronezh	.	.	xx	xx	.	.	.
Belgorod	.	.	.	xx	.	.	.
Kherson, Dniepropetrovsk, Alma-Ata	.	x	x	.	.	.	.
Moldavia, North Kazakhstan	.	.	x	x	.	.	.
Kursk, Lipetsk	.	.	.	x	.	.	.
Azerbaijan, Uzbekistan, Turkmenia	–	–	.	.	.	.	.
Zaporozhye, Donetsk‡, Pavlodar Altai	.	–	–	.	.	.	.
Kuibyshev, Chelyabinsk, Omsk, Novosibirsk	.	.	–	–	.	.	.
Kharkov	.	.	–	–	–	.	.
Tula, Orel, Chernigov, Cherkassy	.	.	.	–	–	.	.
Brest, Gomel, Chernovtsy	.	.	.	.	–	.	.
Lvov, Tatar	.	.	.	– –	– –	.	.
Grodno, Minsk, Kaliningrad, Latvia	.	.	.	.	.	– –	– –

xxx Breeding in large numbers
xx Breeding in small numbers every year
x Rare breeding pairs, not every year
– Disappeared in the 20th century
– – Disappeared by the end of the 19th century

* Formerly Stalingrad. † Formerly Akmolinsk. ‡ Formerly Stalino.

In the 19th century the numbers of bustards began to decline markedly. In many localities the birds stopped breeding, and a number of territories, one after another, were excluded from their vast area. This happened first in the areas where bustards had appeared comparatively recently, i.e. within the forest zone. After 1838 they were not found in England (Niethammer 1942), and shortly later in France either. In the sixties bustards disappeared from the Kaliningrad region, and by the end of the century from some other regions of the European part of the USSR (Menzbier 1893). At present the range of this subspecies has greatly decreased everywhere. The succession of its reduction within the USSR is shown in Table 3. First (as early as in the 19th century) bustards ceased breeding in the areas situated in the subzone of mixed forest, then (at the beginning of the 20th century) in the subzone of broadleaved forest. In forest-steppe they remained longer, but in the first half of the 20th century they disappeared from most of the forest-steppe areas too. In mountain steppes there are almost no bustard either. Only in some plain steppe areas do considerable numbers of bustard continue breeding.

In order to ascertain the present distribution and the numbers of bustard in the USSR, a special inquiry was conducted in 1971 in which Republican and Regional Game Management Administrations, Hunters' Associations and ornithologists took part. The information obtained by means of the inquiry is summarized in Table 4. The accuracy of some data is not very high and the indications of numbers should be considered as approximate. Nevertheless, these data give us a clear indication of the numbers and distribution of bustards in the USSR. At present, the total number of breeding pairs of the European subspecies on the territory of the USSR is between 2200 and 2300, and that of the Eastern subspecies (according to much less accurate data) about 500 or 600 pairs (Table 5).

The bustard range does not make a solid unit now. Areas where the birds are still breeding alternate with localities where they are not found at all (Map 2). Within the USSR several geographical populations of the European Bustard occupying isolated areas may be singled out (Table 6). (*a*) The Black Sea population whose main part inhabits the Crimea and Odessa regions. The birds breeding in the Poltava region, though their habitat is separated from the main area, also belong to this population. (*b*) The Volga-Don population which is made up of the birds breeding on the Middle and Lower Volga (Saratov and Volgograd regions) and in the middle part of the Don (Voronezh and Rostov regions). (*c*) Formerly the Caucasus Foreland population occupied a big area and was rather numerous. Now it is represented only by small groups of birds inhabiting rather small areas on this vast plain: the lower reaches of the Kuban, the area of the Manych-Gudilo Lake, North Caspian Lowland from Kalmykija to Daghestan and the Ergeny Hills,

TABLE 4

PRESENT DISTRIBUTION AND NUMBERS OF *O. t. tarda* IN THE USSR

Regions, Territories, Republics 1	Number of districts where bustards are breeding 2	Number of breeding pairs 3	Number of birds (ad. + subad.) 4
Odessa reg.	9	(150)*	350—400
Moldavian ASSR	3	3	—
Nikolayev reg.	8	(50)	—
Kherson reg.	1	rare birds, not regularly	—
Crimea reg.	12	500	—
Dniepropetrovsk reg.	2	rare birds	—
Poltava reg.	6	(30)	—
Bryansk reg.	1	1	—
Lipetsk reg.	1	rare birds, not regularly	—
Belgorod reg.	1	10	59
Voronezh reg.	4	(40)	130
Rostov reg.	7	(25)	—
Saratov reg.	18	(390)	1187
Volgograd reg.	8	112	—
Kalmyk ASSR	2	(30)	—
Daghestan ASSR	2	(25)	—
Checheno-Ingushetia ASSR	1	10	—
Stavropol Territory	2	(10)	40
Krasnodar Territory	1	(8)	16
Orenburg reg.	6	(40)	100
Uralsk reg.	7	more than (40)	—
Guryev reg.	2	(20)	—
Aktyubinsk reg.	4	(80)	200
Turgay reg.	1	50	—
Kustanay reg.	1	20	—
North Kazakhstan reg.	3	rare birds, not regularly	—
Kokchetav reg.	2	rare birds	—
Tselinograd reg.	4	(50)	—
Karaganda reg.	6	(250)	780, including young stock
Taldy-Kurgan reg.	4	more than 50	—
Alma-Ata reg.	1	rare birds	—
Semipalatinsk reg.	6	270	—
East Kazakhstan reg.	1	(20)	—
TOTALS	137	(2300)	(7000)

* The number of breeding couples given in brackets is defined approximately, by calculation.

TABLE 5

PRESENT DISTRIBUTION AND NUMBERS OF *O. t. dybowskii* IN THE USSR

Republics, Territories and Regions	Number of districts where bustards are breeding	Approximate number of breeding pairs	Approximate number of birds (ad. + subad.)
Krasnoyarsk Territory ..	1	rare birds	—
Altai Territory ..	1	rare birds	—
Tuva ASSR ..	5	200	600
Buryat ASSR ..	5	250	750
Chita reg. ..	6	100	300
TOTALS	18	550	1650

TABLE 6

APPROXIMATE NUMBERS OF THE MAIN GEOGRAPHICAL BUSTARD-POPULATIONS IN THE USSR (1971)

Geographical populations	Number of breeding pairs	Number of birds (ad. + subad.)
Black Sea ..	735	2250
North Caucasus ..	90	300
Volga-Don ..	575	1750
West Kazakhstan ..	120	400
Central Kazakhstan ..	430	1250
East Kazakhstan ..	350	1050
Tuva ..	200	600
Trans-Baikal ..	350	1050

(*d*) The West Kazakhstan population which inhabits the Urals region and the adjoining areas of Orenburg and Aktyubinsk regions. (*e*) The Central Kazakhstan population occupies a vast territory from the Turgay valley to the eastern borders of Kazakh small-hills area (i.e. 65°-70°E.). Recently the density, as well as the total number, of this population has declined. Its number is somewhat higher only in Karaganda region. (*f*) The East Kazakhstan population inhabits the steppes of Semipalatinsk region and the foothills of Tarbagatay and Dzungarsky Alatau, The range of Eastern Bustard subspecies (*O. tarda dybowskii* Taczanowski) extends mainly outside the Soviet Union, in Mongolia and China. It extends from the depression of Great Lakes in the west of Mongolia to North Manchuria in the east (Kozlova 1930 ; Tugarinov 1929, 1932 ; Bannikov & Skalon 1948 ; Cheng 1947). The landscapes of true steppes (*Aneurolepidium*, feather-grass, and shrub steppes) prevail on this vast territory, considerable areas being also under meadow and mountain steppes. Within the USSR there are only some strips of the range of this subspecies (Map 3). Therefore the name East Siberian Bustard, which is sometimes used, is not a proper one. It would be more correct to call it the East Asian or Central Asian Bustard.

The extreme western area of its distribution in the USSR is Tuva, where bustard is breeding in the steppes of Ubsa Nor and Tuva depressions. Not so long ago it was found in Minusinsk forest-steppe as well. Farther to the east, bustard inhabits the steppe areas of the Selenga river basin. From there it moves to the Vitim uplands,[1] where it is breeding in very small numbers in lake depressions (Arakhley and Eravnin lakes) and in the meadows among larch taiga. At one time bustard was found even farther to the north (in the valley of the Barguzin river and in Olkhon[2] district, on the western coast of Lake Baikal ; now they are not found there. Another bustard area in the USSR is Dauria.[3] Meadow steppes (*Aneurolepidium*, tansy, and feather-grass ones) are typical for this area, as they are for the Selenga lowland. The number of populations mentioned is not big (Table 5) and tends to be reduced. However our data concern only a small portion of the Eastern subspecies area, so we cannot make any conclusion about the total number of its population.

Not so long ago bustards were breeding in the USSR in two more areas of the Far East : in the middle part of the Amur river, in the plain between the mouth of the Zeya river and the mountain range Malyj Khingan, and somewhat further south in the lowlands near Khanka Lake (100 km north of Vladivostok). Both these regions are situated in the area of oak-forests and are separated from the main bustard area by a wide belt of broadleaved forests. Bustard could inhabit these areas only after they had been deforested and cultivated, so that the boundaries of the main area moved to the north and to the east. It should be mentioned that L. Schrenk (1861), who was travelling in the middle part of the Amur in 1854-56, wrote in his account that no bustards were found there. So it is clear that they colonized the Amur territory only at the end of the 19th century. In the first half of the 20th century bustards bred regularly in four districts of the Amur region (Barancheev 1954),

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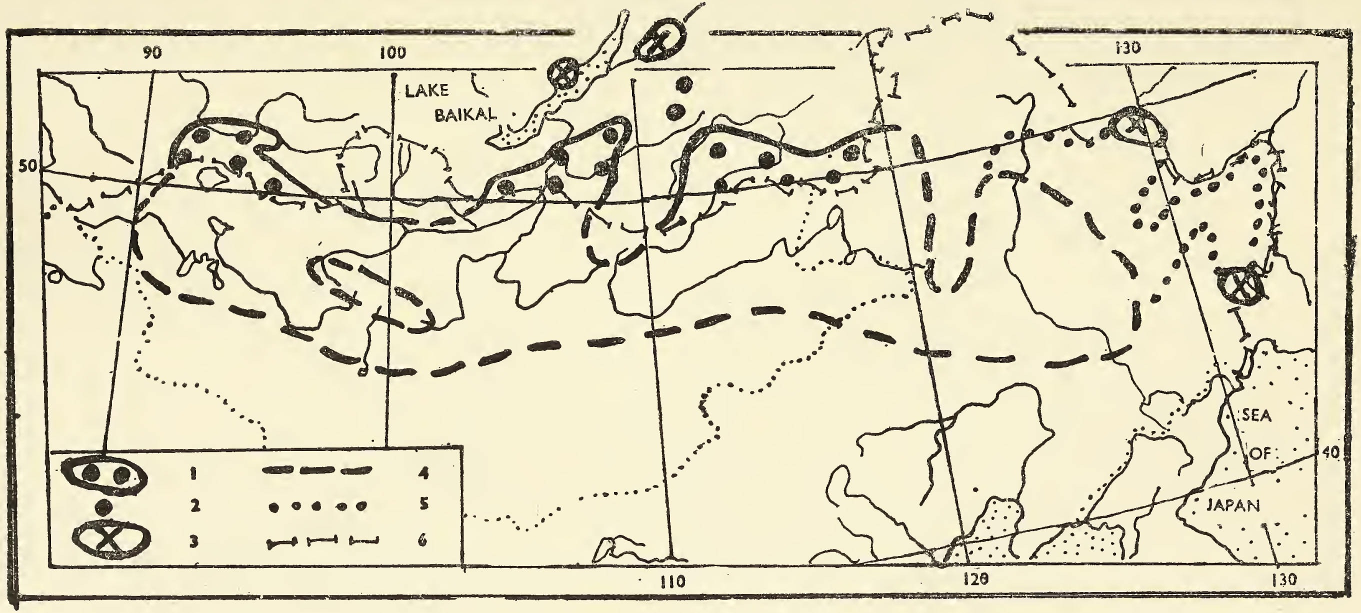
[1] The Vitim river rises north of Chita and joins the Lena at Vitim city.

[2] An island in Lake Baikal.

[3] SE. Chita.



90
100
110
120
130
130
50
40
LAKE
BAIKAL
SEA
OF
JAPAN
1
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6

Map 3. Distribution of *Otis tarda dybowskii*.

1. Present distribution. 2. Known breeding areas. 3. Isolated breeding areas. 4. Breeding regions at the end of the 19th and beginning of the 20th century. 5. Main breeding area in Mongolia and China; 6. Area colonized only at the end of the 19th century.

but in the last ten years there has been no reliable evidence about them in this area, and they have not been found near Khanka Lake either.

The contraction of bustard area within the territory of the USSR is indicative of its considerable decrease in numbers. It is difficult to describe the extent of this process, as bustard population surveys have been performed rather seldom, and have been carried out in different regions and on different dates, so that the data are hardly comparable. Thus, in August 1941, 18 bustards were found per 1000 km in Turgay region, the registering being done from a car. Fifteen years later (1955-57), only 5·5 birds per 1000 km on the average were found on the car routes covering most of North Kazakhstan. In Tselinograd region the number was much higher. In May 1936, 16·7 bustards per 100 km were found here, and in 1947, even 58 birds (Gavrin 1962). At present, the total number of bustards in Tselinograd region probably does not exceed 200 birds, in Turgay region 150 birds, and in Kustanay region some dozens of birds. In North Kazakhstan region breeding bustards have been registered only 3 or 4 times during the last eight years.

The data concerning bustard numbers in Central and Eastern Europe are more definite (Table 7). One may suppose that the whole stock of Baltic population (the GDR, Poland) does not much exceed 1000 birds, that of the middle Danube population (Austria, Hungary, Czechoslovakia) about 3000 birds, and that of the lower Danube population (Rumania) probably about 1500 birds. The number of Iberian, North African and Near East populations is not known, but they are hardly numerous, as bustards are rather sporadic there.

TABLE 7

Countries	1935-36	1939-41	1954-57	1961-63	1969-71	Authors
GDR	—	4320*	2000	—	700-900	Gewalt 1959, 1969; Niethammer 1942; Schiemenz 1972; Gentz 1961.
Poland	832*	—	450	301	—	Sokolowski 1939, 1958- Gewalt 1959; Radkiewicz 1970.
Austria	—	1202	390	—	200†	Niethammer 1942; Gewalt 1959; Festetics 1968.
Hungary	—	8447	3450-4310	—	2300	Gewalt 1959; Fotor. Nagy & Sterbetz 1971;
Czechoslovakia	2000	—	1100	920	700	Necas & Hanzl 1956; Ferianc 1963; Gell 1973.
Rumania	—	—	—	2000	—	Almasan & Popescu 1963.

* The indices of bustard numbers in Poland and in the GDR (1936 and 1939) are brought to conformity with the present boundaries of these countries.

† In 1967.

Quantitative estimates of bustards conducted in the countries of Central Europe show that during the 20 years since the late thirties, their number was almost halved. During the following 10 years it was halved again. The most complete data available concerns the GDR territory. If we assume that the bustard population on this territory was 100 in 1900 then by 1939 it had decreased to 27, by 1961 to 17, and by 1971 to 7. Over the period of 70 years the bustard stock declined by 93 per cent (Schiemenz 1972). This happened under conditions of well-organized protection of the species and in spite of measures intended to ensure its preservation (special devices on farm machines to frighten away the birds, artificial egg incubation, rearing young birds from abandoned nests, etc.).

The main cause of the continual decline in the number of bustards is the changing environment. It is well known that bustards do not avoid agricultural lands and readily breed in the fields, but their successful breeding there depends on the kind and dates of agricultural work. With every year farming becomes more intensive, mechanization and chemicals being applied more widely. Some fields are cultivated about five times a year, and almost every time with machines. The network of roads is growing, and the number of human settlements is increasing too. These are factors which greatly disturb birds and cause, for example, in the GDR, the loss of 80 to 90 per cent of bustard egg clutches (Schiemenz 1972). The wide application of pesticides is an important factor in the general decline of bustard numbers. Birds may perish because of chemical poisoning, but to our mind the indirect effect of pesticides on bustard population is of much greater importance. In the bustard's dietary, animal food plays a great role. For young birds, which cannot yet shift far away from the hatching place, this food is of the greatest importance, and is probably the reason why bustards often make their nests in the steppe very close to underground anthills (Spangenberg 1946). Investigations conducted by V. F. Ryabov & Z. Y. Ivanova (1971) in Kustanay region showed that animal food accounts for 96 per cent by weight in a young bustard's diet and 38 per cent on the average in that of adult birds. However, even for adults the share of animal food reaches 80 per cent in late summer. With the present system of field crop cultivation, arable lands are fused into big areas thoroughly cleared of insects and rodents. Meadows and pastures occupy very small areas. As a result bustards, and especially their young, are absolutely deprived of the animal food they need.

For a long time both these factors interfering with bustard reproduction had only local effects, the bustards on the vast steppe territories continuing their breeding. But then the situation changed. In Hungary, Czechoslovakia, Poland, in the GDR, and later in the south of the European part of the USSR, the areas of virgin lands disappeared and those of dry meadows were minimized due to the indoor maintenance of cattle. Sowing spring cereals instead of winter cereals was highly unfavourable for bustards. In the late forties and early fifties, vast areas of virgin and fallow lands were ploughed up in the steppes of West Siberia and Kazakhstan. The economic development of these territories was accompanied by the increase of populated areas and by the construction of roads. In this area living conditions have become much more difficult for bustards. The number of birds has markedly declined and continues to decline, in spite of the fact that hunting has stopped completely.

What can be done to stop this process and to prevent the danger of complete disappearance of this valuable species? The first requirement is a complete ban on shooting or trapping bustard. However, as has been said before, protection alone, even the most complete and active protection, cannot increase the stock. To achieve that, it is necessary to make long-term plans for the preservation of biotopes in which bustard can successfully reproduce. Both natural (areas of virgin steppe) and semi-natural biotopes of economic value (pastures, hay meadows, areas under perennial fodder grasses, etc.) belong to this group. These lands should be conserved not only to save bustard, but also to preserve a large complex of steppe animals which are also threatened. Among birds these are the Little Bustard[1], the Demoiselle Crane[2], the Sociable Plover[3], the Blackwinged Pratincole[4], the Steppe Eagle[5] and the Pallid Harrier[6], the Black Lark[7], the Whitewinged Lark[8] and others.

A few remaining areas of virgin steppes should become nature reserves. Semi-natural steppe complexes with their plants and animals should also be protected by the State, and a rational utilization regime established for their preservation. The problem of what is in store for the steppe animals is no less disturbing than the fate awaiting the inhabitants of wetlands and marshes which are being protected in accordance with such international projects as MAR[9], AQUA[10]: and TELMA[11]. That is why the elaboration of an international project for the conservation of natural and semi-natural steppe ecosystems and of the animal species inhabiting them, is an extremely urgent one.

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[1] *Otis tetrax.*

[2] *Anthropoides virgo.*

[3] *Vanellus gregarius.*

[4] *Glareola pratincola.*

[5] *Aquila nipalensis.*

[6] *Circus macrourus.*

[7] *Melanocorypha yeltoniensis.*

[8] *Melanocorypha leucoptera.*

[9] IUCN and UNESCO project for the conservation and management of temperate marshes, bogs and other wetlands.

[10] IUCN and UNESCO project for the conservation of aquatic habitats (lakes and rivers).

[11] IUCN and UNESCO project for the conservation of all actually or potentially peat-forming ecosystems.

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Problems resulting from the discontinuous distribution of *Muscicapa latirostris* Raffles[1]

ERWIN AND VESTA STRESEMANN

What directed our interest to *Muscicapa latirostris* was initially the fact of its being a winter visitor in tropical South-East Asia, arriving there from its Palaearctic breeding range in September or October after a long journey and leaving again in April or early May. In this regard the migratory movements of the species agree fairly well with those of some other Palaearctic passerines like *Lanius tigrinus*, *Lanius cristatus*, *Pericrocotus divaricatus* and *Locustella certhiola*, which all have recently been shown by the present authors to have two complete moults, a postnuptial one on breeding grounds and a prenuptial one in their distant winter quarters. This similarity of migration patterns induced us to study the moult of *Muscicapa latirostris* in the hope to discover an additional case of ' two complete moults each year '. But our expectation did not come true.

Witherby (1938), who believed *Muscicapa latirostris* to nest in the Palaearctic region only, published his opinion about the plumage changes of this flycatcher as follows : ' Winter—This plumage is acquired by a moult of the body feathers in July-August, but wings, wing-coverts and tail are not moulted in autumn. Summer—From February to May a complete moult takes place.' This picture proved on examination to be entirely wrong. In fact the species undergoes a complete postnuptial moult on its Palaearctic breeding grounds in July/August/September, and in winter quarters does not moult at all ! Young birds retain the first generation of flight-feathers for about one year. Their partial moult from the spotted nestling plumage to the adult dress begins probably, as in *Muscicapa striata* (Heinroth 1926, p. 53), at the bird's age of nearly 27 days and lasts about one month. Freshly moulted first-year birds are distinguished from fully adults by pale-cinnamon tips of the greater secondary coverts, retained from the nestling plumage. Thus our results conform to those of Whistler's (in Ali 1938, p. 299).

The postnuptial moult lasts about 60 days. In the sequence of feather replacement this species agrees with *Passer domesticus* (Zeidler 1966). For details see the Appendix.

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[1] Received August 1972.

Besides the highly migratory Northern populations there are smaller, scattered populations and single pairs that nest in the tropics. Individuals remaining in the tropics all through the Northern summer have been recorded from various countries, chiefly from India, but also from Malaya, Thailand and Burma (Deignan 1957). The first author to prove nesting in India seems to have been B. Shelley (1894), who recorded it in the Vindhya Range near Mhow in June. His note has been quoted in full by Stuart Baker (1906), who added a second case. Hartert (1910, p. 478) however considered both instances doubtful and suspected a confusion with *Muscicapa sibirica fuliginosa* (=*cacabata*). Even in 1934 he had not changed his point of view, disbelieving in the many additional records since published by Stuart Baker (1924, p. 249 and 1933, p. 216). His negative attitude was not fully shared by Whistler (in Ali 1933, p. 388) though he admitted : ' More information is needed about the breeding of this flycatcher in India.'

Such additional information will soon be given in Vol. 7 of Ali's and Ripley's monumental HANDBOOK. Dr Dillon Ripley kindly sent us in advance a photocopy of the text on *Muscicapa latirostris*. From this one learns that the species is :

(*a*) a fairly common summer visitor to the foothills of the Himalayas

(*b*) a common breeder in the Vindhya Range (hills round Sehore and Mhow)

(*c*) a scarce breeder in the southern parts of the Western Ghats, probably also in the Eastern Ghats and in the Biligirirangan Hills (Mysore).

The breeding population of India is migratory in the Himalayas and the Vindhya Range, where it appears on its breeding grounds in April and departs in September, while in the Ghats there is a resident population. *Muscicapa latirostris* is a winter visitor to the foothills of Dehra Dun from October to February. It also winters in Ceylon, where it is most common from October to March (loc. cit.).

Since the highly migratory Palaearctic and the Indian populations cannot be distinguished by colour or measurements (Vaurie 1954) it remains uncertain to what extent Palaearctic immigrants invade Indian territory in autumn to stay there for the winter. Ali & Ripley apparently consider this influx to be negligible. They regard the main winter quarters of the palaearctic population to be 'South-east Asia, the Philippines and Indonesia'. But the species is almost unknown in the Philippines and to South-east Asia should be added Burma, where it is very common after 24 September (Oates 1883) and whence numerous specimens are likely to extend their migration into India.

What stimulated our interest in this species and its most unusual distribution was the question whether the two widely separated populations, the Palaearctic and the Indian, agreed with regard to season of moult. Considering the differences of day length, climatic factors and length of migration, a notable difference in the timing of this cyclic process could be expected.

To our surprise the difference proved to be trifling or even non-existent.

Due to the absence of migration and the continuous presence of flying insects, breeding may start in the resident population of South India as early as in April, while in North India it does not begin before May (Ali & Ripley). In Japan, where this species arrives about 15 April, the second half of May has been recorded as the starting-point for nidification (Jahn 1942).

Consequently, the complete postnuptial moult may begin in South India at a somewhat earlier date than in the foothills of the Himalayas and in Hondo (see the Appendix).

Muscicapa latirostris, known to be a widespread and locally common breeding bird in India, has also been recorded in summer from several localities in South-East Asia (Deignan 1957), but convincing proof of its breeding there remains very scarce. Such proof exists for:

Southern Burma: Oates collected at Kyeik-Padein (near Pegu) an adult on 21 July and a ' quite young bird ' on 30 July (Oates 1883, p. 277). The adult specimen was considered by Deignan (1957) to belong to his ' new species ' *Muscicapa williamsoni* (about which *see* Vaurie *in* Mayr 1971).

Thailand: Occasional nesting is testified by a skin in the Field Museum of Natural History (Reg. No. 81181), collected 15 Aug. 1921 at Ban Hia (13°30′N, 100°35′E), south of Bangkok, in the vicinity of Paknam, according to M. Traylor (*in litt.*), who added: ' The specimen is about 95% in first winter plumage, with scattered juvenal (=nestling) feathers on crown and back. Below, the brownish breast band is noticeably streaked. It fits very closely Deignan's description of *williamsoni*, although I find it hard to believe that there are two resident species, *M. latirostris* and *M. williamsoni*, in Southern Asia.'

Western China: *Muscicapa latirostris* had generally been supposed to occur in China on migration only. We were therefore much surprised to learn that Dr George Watson, while perusing the material of the U.S. National Museum, had found 4 skins of this Flycatcher in primary moult collected in the mountains of Yunnan and Szechuan by S. F. Rock and David C. Graham respectively (see the Appendix).

Proof is lacking, though nesting has been suspected in:

Malaya: ' It is possible that a few pairs remain throughout the year and breed in the mountains ' (Robinson 1928, p. 130). A skin from the state of Selangor, dated 17 August, has been attributed by Deignan to his ' species ' *williamsoni.*

Annam : ' Possibly there may be a resident form in the mountains of South Annam ' (Riley 1938, p. 446, basing this remark on a specimen collected there on 10 May 1918).

The extension of the breeding range of this migratory bird from the temperate region of Japan, Eastern Siberia and neighbouring countries (see Vaurie 1959) to the hills of India without appreciable effect on morphology or physiology of the settlers may have been initiated by single pairs which, instead of returning in spring, remained in winter quarters for reproduction. Owing to some physiological preadaptation of the species this may have been frequently repeated by single birds up to the present time, since in autumn there is (probably) a constant influx of Palaearctic migrants belonging to *Muscicapa latirostris*, and the 'swamping effect ' (Mayr 1942, pp. 244-5) prevents differentiation of populations which remain isolated during the summer months only.

What may be the result if isolation is complete and lasts for a long period is shown by *Muscicapa* (*latirostris*) *segregata* Siebers. This resident species (or rather semispecies) is confined to Sumba, one of the Lesser Sunda Islands. It differs constantly from *M. latirostris* by longer bill and wing shape (Siebers 1928 and Rensch 1931). The length of primaries 8 and 9 (from within) is reduced relatively to primary 7, a frequent difference between migratory and resident populations of the same species (see Mayr 1963, p. 324 : ' wing rule '). The colour, however, remained unchanged. Not so the season of breeding and, consequently, of moult. Specimens in the Zoological Museum of Berlin prove a great difference relative to Palaearctic and Indian birds, No. 30.1691 is in complete nestling plumage on 25 March 1925[1], while two other young birds (Nos. 30.1692 and 30.1693), dated 28 and 30 March respectively, have already undergone the post-nestling moult, as shown by the cinnamon-coloured tips of the greater secondary coverts which signify first-year birds. This suggests the breeding of *segregata* about January or February —probably in adaptation to the local annual rhythm of ample food supply.

Obviously *M. segregata* is a relic from a quaternary period when Palaearctic migrants used to penetrate farther into the Malay Archipelago than nowadays, even reaching Australia, as *Botaurus stellaris, Fulica atra, Porzana pusilla* and *Podiceps cristatus*. Some of these migrants settled there and became the ancestors of Australian subspecies (Stresemann 1939, p. 417).

Muscicapa segregata fits in this group of colonists. Its ancestor *M. latirostris* does no longer reach the Island of Sumba in the migratory period. In present times it goes no farther east than Java, and there is no record known from the intervening islands of Bali, Lombok, Sumbawa and Flores. Thus the isolation of the Sumba population has long since become perfect.

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[1] According to Siebers (1928) and Rensch (1931, p. 379), Dr Dammerman in addition collected two other skins in nestling plumage, dated 22 and 28 March 1925.

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SUMMARY

Muscicapa latirostris moults the entire plumage on breeding territory. The innermost primaries are replaced by new ones soon after (or even before ?) the end of parental care. The birds nesting in India do not differ appreciably from the highly migratory Palaearctic birds, either in morphology and breeding season or in timing of moult. It is suggested that this lack of differentiation may be due to the swamping effect which results from incomplete isolation of the Indian population.

What may be the effect if isolation is complete is shown by *Muscicapa* (*latirostris*) *segregata*, a descendant of *M. latirostris latirostris*, confined to the island of Sumba. It agrees with the latter in colour, but differs by having a blunter wing-tip and by the season of reproduction and moulting.

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APPENDIX

Postnuptial moult (complete)

A. PALAEARCTIC REGION

1. 10 July 1956, ♀, Manchuria : Little Khingan—Piechocki No. 37
Pr. 1 in sheath gr. 1 cm, 2 in sheath gr. 2 cm, rest old. **Sec. tail, body** old, no moult.

2. 14 July 1956, ♀, Manchuria : Little Khingan—Piechocki No. 56
Pr. 1 and 2 in sheath, rest old. **Sec. tail, body** old, no moult.

3. 15 August 1900, Hokkaido : Nemuro—München No. A 692
Pr. 1 and 2 in sheath, 3 lacking, rest old. **Sec.** 8 lacking, rest old. **Tail** old. **Body** many germs on throat and pteryla gastraei.

4. 15 August 1900, Hokkaido : Nemuro—München No. A 682
Pr. 1 to 4 new, 5 almost full grown, 6 gr. 3/4, 7 in sheath 1 cm, 8 to 10 old. **Sec.** 1 gr. 4/5, 2 in sheath 2 mm, 3 to 6 old, 7 gr. 1/2, 8 new, 9 lacking. **Tail** four rectrices gr., 5 and 6 old. **Body** moult almost completed, gr. feathers only on head and throat.

5. 27 August 1900, Kurilas : Iturup—München No. A 695
Pr. 1 to 4 new, 5 almost full grown, 6 gr. 3/4, 7 gr. 1/3, 8 out, 9 and 10 old. **Sec.** 1 and 2 gr. 3 to 6 old, 7 gr. 1/2, 8 and 9 new. **Tail** all rectr. gr. 2/3 to 1/2.

6. 10 September 1900, Kurilas : Iturup—München No. A 697.
Pr. 1 to 6 new, 7 with rest of sheath, 8 gr. lacking 1 cm, 9 gr. 3/4, 10 gr. **Sec.** 1 and 3 new, 4 gr. lacking 1 cm, 5 gr. 1/2 cm shorter than 4, 6 gr. 3 mm shorter than 4, 7 to 9 new (7 with rest of sheath). **Tail** new. **Body** everywhere some gr. feathers, otherwise new.

B. WESTERN CHINA

All information communicated by Dr G. E. Watson

7. 28 June 1929, ♀, Szechuan : Mupin—Washington No. 313582—All feathers old.

8. 31 July 1928, ♀, Szechuan : Ningyen Fu 6000 ft.—Washington No. 310735
Pr. 1 new, 2 almost full gr., 3 gr. 3/4, 4 gr. 1/4, 5 to 10 old. **Tail** all old.

9. 22 Aug. 1923, ♀, Yunnan: Lichiang Plain 8200 ft.—Washington No. 296396
Pr. 1 to 7 new, 8 gr. 3/4, 9 gr. 1/2, 10 out. **Tail** all new.

C. INDIA

10. 20 July 1934, ♂, Mysore : Biligirirangan Hills—Coll. Ripley No. 1833—Has started primary moult.

11. 23 Aug. 1938, ♀, Indore St. : Bijwar 1450 ft.—Bombay No. 4156
Pr. 1 to 3 new, 4 and 5 still gr., 6 gr. 2/3, 7 pin 1 mm, 8 to 10 old. **Sec.** 1 still gr., 2 gr. 1/3, 3 to 6 old, 7 gr. 2/3, 8 and 9 new. **Tail** 1 new, 2 to 6 gr. in centrifugal sequence (2 almost full-gr., 6 gr. 1/2). **Body** all feathers new or gr., still many in pin.

12. 24 Aug. 1938, ♂, Indore St. : Bijwar 1450 ft.—B.M. 1949. Whi. 1.10703
Pr. 1 to 5 new, 6 still gr., 7 gr. 3/4. 8 gr.1/2, 9 pin, 10 out. **Sec.** 1 and 2 new, 3 still gr., 4 gr. 2/3, 5 pin 1 cm, 6 pin 3/4 cm, 7 to 9 new. **Tail** 1 to 5 new, 6 still gr. **Body** moult completed.

13. 24 Aug. 1924, ♂, Baghat St. (NW Himalaya) : Koti 3500 ft.—Bombay No. 16916
Pr. 1 to 5 new, 6 and 7 still gr., 8 gr. 3/4, 9 gr. 1/3, 10 old. **Sec.** 1 new, 2 still gr., 3 gr. 1/2, 4 pin 1 cm, 5 and 6 old, 7 still gr., 8 and 9 new. **Tail** 1 to 3 new, 4 still gr., 5 gr. lacking 1 cm, 6 gr. 2/3. **Body** some feathers still gr.

14. 6 Sept. 1938, ♂, Dhar St. : Gujri 750-1000 ft.—Bombay No. 4155
Pr. 1 to 6 new, 7 still gr., 8 gr. 1/2, 9 gr. 1/3, 10 out. **Sec.** 1 and 2 new, 3 gr. 1/2, 4 pin 1 1/2 cm, 5 pin 3 mm, 6 out, 7 to 9 new. **Tail** 1 to 5 new, 6 still gr. **Body** moult completed.

Similitudes and differences of the Indian and Indochinese avifaunas[1]

J. Delacour

The two great tropical peninsulas of Asia form two faunal subregions of the Oriental Region. Both are sharply separated from the temperate areas to the north, for the greatest part, by the highest mountains in the world and, as can be expected, their floras and faunas are closely related. But India is connected in the west with Asia Minor and Arabia, two arid countries, while Indochina is gradually linked to China in the north-east, and to Malaya (and in the recent past to Borneo and Sumatra) in the south, respectively moist-temperate and equatorial in climate. Also it has many more local microregions, due to broken-up chains and plateaux, and to large rivers, with specialized and often endemic populations.

The western part of the Indochinese Peninsula of course resembles India more nearly, and, as it extends farther north, towards the Himalayas, the faunal changes are quite gradual in a number of cases.

The lower and more open parts of the whole Oriental Region, and also the cultivated lands, are often inhabited by the same species, represented by local but usually fairly similar subspecies. It is in the higher, forested districts that the avifauna becomes more distinct, with many striking forms usually confined to relatively small territories which constitute special habitats.

To illustrate more strikingly the differences between the two subregions, it is preferable to consider, on the one hand, continental India, without Ceylon or other islands, and on the other, the eastern parts of Indochina, made up of Vietnam (Tonkin, Annam and Cochin-China), Cambodia and Laos, which used to form French Indochina. Being situated at the extreme south-east of Asia, they possess a much richer and more specialized fauna than the western parts, Thailand and Burma. As also I have spent some twenty years exploring that country and studying its bird life, I am more familiar with it.

It is not my intention, in a short note, to make a general survey of the similitudes and differences of these avifaunas as a whole ; it would fill volumes ! But I shall venture to show those existing in three families which are particularly well represented in the Oriental Region, better perhaps than in any other one : Phasianidae, Picidae and Corvidae. It will offer a good sample of the general picture.

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[1] Received December 1971.

One has above all to remember that India is a much larger area than eastern Indochina, so that the actual numbers of species found in each of the two do not represent its real comparative wealth. The truth is that, for areas of comparable size, Indochina is actually the richer of the two.

PHASIANIDAE

North-west India and the Himalayas have a large population of game birds akin to the palearctic ones, none of which occur in Indochina. Among the Phasianidae popularly known as 'partridges' without long tails or bright colours, the following genera are represented in India, but not in Indochina : *Lerwa*, *Ammoperdix*, *Tetraogallus*, *Tetraophasis*, *Alectoris*, *Perdix*, *Ophrysia*. All are of palearctic or Himalayan origin.

Two other genera, confined to the warmer parts of India, are not represented in Indochina : *Perdicula*, *Galloperdix*. There are five species of *Francolinus* in India : *francolinus*, *pictus*, *pondicerianus*, *gularis*, *pintadeanus*. The last named is the only species to reach Indochina and to extend to southern China. It can be noted here that the centre of distribution of *Francolinus* is Africa. Of the three species of Indian quails, *Coturnix coromandelica* is endemic, while the migrant *C. coturnix* and the resident *C. chinensis* are also found in Indochina.

Bambusicola fytchii lives in the north of both subregions, and there are only four species of the forest partridges (*Arborophila*) in India : *atrogularis*, *mandellii*, *torquata* and *rufogularis*. The last two, as slightly different subspecies, also inhabit Indochina, where four more species are found : *brunneopectus*, *cambodiana*, *davidi*, *chloropus*.

Among the genera accepted as 'pheasants', *Ithaginis*, *Lophophorus*, *Pucrasia*, *Crossoptilon*, *Catreus*, *Syrmaticus* do not enter French Indochina although some reach northern Burma. *Tragopan* has four species in India : *melanocephalus*, *satyra*, *blythii* and *temminckii*, the last of which only is found also in north-west Tonkin, at high altitudes. The palearctic *Phasianus colchicus*, however, is found in northern Indochina, close to China.

India has but one polymorphic species of *Lophura* (*leucomelana*) while eastern Indochina is the home of four: *nycthemera* (with many subspecies), *imperialis*, *edwardsi* and *diardi*. It also possesses the Crested Argus (*Rheinartia*) and two Peacock Pheasants : *Polyplectron germaini* and *P. bicalcaratum*, the latter also found in northern India.

The Red Junglefowl (*Gallus gallus*) is common to both subregions, but *G. sonneratii* is peculiar to western and southern India.

The Indian Peafowl (*Pavo cristatus*) of India is replaced in Indochina by the Green (*P. muticus*).

PICIDAE

Woodpeckers are particularly numerous in the Oriental Region; there are no fewer than 32 species in India and 2 in Indochina, many of them inhabiting the same territory, where they are common.

India has in the north-west representatives of one palearctic species, *Picoides tridactylus*, while another one, *Picoides major*, is found in both peninsulas. Another *Picus* (*squamatus*) and four *Picoides* (*himalayensis, assimilis, auriceps* and *nanus*; the last is merged by some authors into *P. canicapillus* of northern Indochina) are proper to India, as are *Dinopium benghalense, D. shorii* and *Chrysocolaptes festivus.*

Indochina has of its own *Picus vittatus, P. erythropygius, P. rabieri* and *Meiglyptes jugularis.*

The following are common to both subregions, with sometimes very well characterized subspecies: *Jynx torquilla, Picumnus innominatus, Sasia ochracea, Micropternus brachyurus, Picus canus, P. myrmecophoneus, P. flavinucha, P. chlorolophus, Dinopium javanense, Chrysocolaptes lucidus, Gecinulus grantia, Mulleripicus pulverulentus, Dryocopus javensis, Hypopicus hyperythrus, Picoides darjellensis, P. cathpharius, P. macei, P. atratus, P. mahrattensis, P. canicapillus, Hemicircus canente, Blythipicus pyrrhotis.*

CORVIDAE

Crows, Magpies and Jays are represented by many species in the Oriental Region, much more numerous there than in any other part of the world: 22 in India and 15 in eastern Indochina. Only 10 are common to both.

A number of palearctic and Himalayan species are found only in India: *Corvus corax, C. frugilegus, C. monedula, Pyrrhocorax pyrrhocorax, P. graculus, Podoces humilis, Nucifraga caryocatactes*, while a few only extend farther east: *Corvus corone, Pica pica, Garrulus glandarius.* Indochina alone has *Corvus torquatus* (also found in China).

Of the tropical forms, India alone possesses three: *Corvus splendens, Dendrocitta leucogastra, Garrulus lanceolatus*, while Indochina is inhabited by four birds, two extending to China or Malaysia: *Cissa whiteheadi* (also found in Hainan), *C. thalassina, Crypsirina temia, C. temnura* (also in Hainan).

The following species are common to both subregions: *Corvus macrorhynchos, Cissa erythrorhyncha, C. flavirostris, C. chinensis, Dendrocitta vagabunda, D. formosae, D. frontalis.*

As is shown by the above examples, the repartition of species varies somewhat in the Oriental Region, their distribution being affected by the greater or lesser abilities to travel of the birds of different families

But the general pattern is fairly constant. It is clear that the birds of both subregions are closely related.

When I started exploring Indochina in 1923, it was not always easy to identify specimens in the field, as there was no practical handbook at hand ; only publications on particular areas, such as Tirant's *Les oiseaux de la Basse-Cochinchine*, and various reports by Oustalet. We often had to use books on Indian and Burmese birds such as those of Oates and Blanford, and later of Stuart Baker. They proved very useful. Much more is known at present on the birds of the Oriental Region. Among the ornithologists most responsible for such progress is Sálim Ali. I am delighted to dedicate to him this small contribution. As I write it, the memory of many happy days in India and in Indochina come back to me, and I cannot but congratulate myself for the luck I had in being able to explore and to study the incomparable fauna of Indochina when conditions there allowed researches to be carried out in safety and relative comfort. I only hope that such favourable conditions will before too long prevail in that marvellous country.

Zoological results of the *Daily Mail* Himalayan Expedition 1954: notes on some birds of Eastern Nepal[1]

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INTRODUCTION

During my stay in Nepal as a member of the *Daily Mail* Himalayan Expedition 1954, mainly in search of the abominable snowman (=*yeti*), I made a small collection of, and observations on, birds as and when opportunities were available. The area covered extended from Kathmandu east to extreme eastern Nepal (Nepal-West Bengal frontier), and the period, between the last week of January and first week of July, 1954. From mid-February to the end of May, however, I worked in Khumbu, in the vicinity of Mount Everest, within the altitudinal range of approximately 3800 to 6000 metres, where most of the specimens were collected. Except in Khumbu and in one or two other areas of collection, observations were made on birds seen mainly along the tracks.

Ornithology of eastern Nepal is not well covered in scientific literature. A few ornithological reports, such as those of Gray (1863) on Hodgson's collection, Stevens (1923-1925), Ripley (1950), Rand & Fleming (1957), Biswas (1960-1964, 1969), Fleming & Traylor (1961, 1964, 1968), and Fleming (1968) covered parts of eastern Nepal. The most comprehensive account of birds of the high-altitude areas of Khumbu has, however, been given by Diesselhorst (1968).

In the following pages, notes on the birds collected and/or observed by the writer in Nepal east of Kathmandu are presented. The number of species and subspecies involved is 133, of which 67 are represented in the collection by 197 specimens.

In the list that follows, forms whose representatives were not collected have been indicated by asterisks preceding their names which are mostly binomial, except where I was reasonably sure of their subspecific identity.

Ecological notes covering many of the collecting localities have already been given in an earlier paper (Biswas & Khajuria 1957), but those that have not been included there are given hereunder.

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[1] Received January 1973.

Bung (*c.* 27°31′N, 86°50′E): This is a large village situated in Okhaldhunga district on the right bank of Hongu Khola and one of its tributaries. It has extensive cultivation on the lower slopes, but higher up there is a good forest of rhododendrons, fir, magnolias, etc. Collections were made in the forest at about 2740 m altitude.

Chainpur (*c.* 1525 m; 27°18′N, 87°20′E): Situated on the ridge between Hinwan and Pilua Kholas (both tributaries of the Arun river) in the Arun watershed, Chainpur is a fairly large village of Dhankuta district. The slopes are extensively cultivated and the terraced fields are dotted with clumps of large trees; patches of forest here and there break the monotony of the sloping landscape.

Dingboche (*c.* 4400 m; 27°54′N, 86°57′E): It is a small summer village situated on a wide slope on the right bank of Imja Khola. It has about a dozen or so stone huts and small patches of cultivation where potatoes and *kuru* (a kind of barley) are grown. Alpine scrub and grass form the main natural vegetation of the area.

Gnachu (*c.* 4800 m; 27°50′N, 86°36′E): Another small summer village used by graziers and situated off the left edge of the Thami glacier. The vegetation of Gnachu consists mostly of dwarf rhododendrons and junipers, grass and other alpine scrub.

[Below] **Khumjung** (*c.* 3810 m; 27°49′N, 86°44′E): A small patch of forest consisting chiefly of fir, birch and rhododendrons. A narrow footpath from the Namche Bazar-Thyangboche trail passes through this forest.

Longbonga Lake (*c.* 4500 m; 27°56′N, 86°43′E): This is the lowermost in the chain of lakes on the upper reaches of the Dudh Kosi river, in the western ablation valley of the Ngojumba glacier. It looks as if the narrow, trickling Dudh Kosi has expanded here into an irregularly triangular lake, the basal side of which is bounded by a steep mountainous wall that separates this valley from that of the Bhote Kosi. The eastern shore of the lake is a small, narrow, flat land covered with dwarf rhododendrons and other alpine scrub.

Pankhoma (*c.* 3050 m; 27°35′N, 86°45′E): Situated near the crest of a ridge between the Dudh Kosi river and Inukhu Khola in Okhaldhunga district. The area is heavily forested.

Phurte (*c.* 3900 m; 27°49′N, 86°42′E): A small village situated on the left bank of the Bhote Kosi river, a little to the west of Namche Bazar. There are a few small plots of cultivation and forests of junipers, rhododendrons, birch, etc. around.

Tesinga (*c.* 3610 m; 27°50′N, 86°44′E): A small village situated on the right bank of the Dudh Kosi river, almost across from the Base Camp. A little hill stream trickles through the wide cultivated area. There are not many trees around, there being only a few fir, birch and rhododendrons, and some scrub lining the Namche Bazar-Thyangboche track which passes a little below the village.

Thammu (*c*. 4150 m ; 27°49′N, 86°41′E) : A small village located on the left bank of the Bhote Kosi river, further to the west of Phurte, to which it is very similar ecologically.

Thonak Lake (*c*. 5000 m ; 28°59′N, 86°41′E) : A glacier lake situated about 2 km north of Gokyo (Dudh Pokhari) in the western ablation valley of the Ngojumba glacier. It is bounded on the west, north and north-east by mountainous walls, and on the east and south there are moraines. Except for a little dwarf alpine scrub and grass on the moraines there is no prominent vegetation around.

Thyangbo (*c*. 4680 m) : A few stone huts with small plots of cultivation here and there, and some alpine scrub and grass, adorn this small summer village located in the Thami Valley a little to the east of Gnachu.

Toujung Lake (*c*. 4800 m ; 27°57′N, 86°43′E) : It is a small, irregularly triangular lake on the Dudh Kosi river, lying between Dudh Pokhari and the Longbonga Lake. There is very little vegetation in this area except some scrub and grass on the lateral moraine of the Ngojumba glacier.

The altitudes given for some of the collecting localities by Biswas & Khajuria (1957) are wrong. Their correct altitudinal figures and their geographical locations are given below :

Base Camp : *c*. 3800 m ; 27°49′N, 86°45′E.
Chugima : *c*. 4850 m ; 27°56′N, 86°44′E.
Ghat : *c*. 2750 m ; 27°43′N, 86°43′E.
Gokyo (Dudh Pokhari) : *c*. 4900 m ; 28°1′N, 86°43′E.
Hunko : *c*. 4050 m ; 27°50′N, 86°40′E.
Marlung : *c*. 4700 m ; 27°53′N, 86°39′E. (Across Bhote Kosi river from Marlung : *c*. 4800 m).
Nah (= Nang) : *c*. 4400 m ; 27°55′N, 86°43′E.
Namche Bazar : *c*. 3800 m ; 27°49′N, 86°43′E.
Pangboche : *c*. 4600 m ; 27°51′N, 86°47′E.
Paré : *c*. 3900-4000 m ; 27°49′N, 86°40′E.
Phakding : *c*. 3000 m ; 27°44′N, 86°43′E.
Phalong Karpo : *c*. 4570 m ; 27°55′N, 86°49′E.
Pheriche : *c*. 4300 m ; 27°54′N, 86°49′E.
Phorcha : *c*. 3960 m ; 27°51′N, 86°45′E.
Tarangan : *c*. 4200 m ; 27°52′N, 86°38′E.
Thami : *c*. 4400 m ; 27°49′N, 86°39′E.
Thugla : *c*. 4700 m ; 27°56′N, 86°49′E.
Yaral : *c*. 3900 m ; 27°51′N, 86°48′E.

In the following pages the measurements of the birds are given in millimetres, and the unsexed specimens indicated by a dash '—'. Sex determined from plumage and not from examination of gonad is indicated in parentheses, (♂) or (♀).

Order FALCONIFORMES

Family Accipitridae

***Elanus caeruleus** (Desfontaines): Blackwinged Kite

A single example of the Blackwinged Kite was observed near Kiranti-chhāp, at about 1500 m (*c.* 27°38′N, 86°4′E), Charnawati Valley, Ramechhāp district, in the afternoon of 31 January. It was quietly perching on a tree overlooking a cultivated field.

Milvus migrans govinda Sykes: Pariah Kite

Dhankuta district: Chainpur: 1— (16 June).

Measurements: 1—: Wing 465, tail 203, bill 40.

Colours of bare parts: Iris dark brown, bill black, cere and gape pale wax yellow, legs and feet wax yellow, claws black.

The Pariah Kite was found up to about 1525 m in eastern Nepal occurring in and about villages.

Milvus (migrans) lineatus (J. E. Gray): Large Indian Kite

Khumbu: Imja Valley: Yaral: 1 ♂ (29 April).

Measurements: 1♂: Wing 509, tail 305, bill 41·5.

Colours of bare parts: Iris dark brown, cere dull greenish white, bill black. legs and feet pale greenish yellow, claws black.

The Large Indian Kite did not appear to be uncommon in eastern Nepal between *c.* 2100 and 3500 m. Below and above this altitudinal range, it appeared scarce. The highest place where it was observed was Dudh Pokhari (*c.* 4900 m), where a single example flew up along the Dudh Kosi river on 14 May at about midday. It soared over the area, alighted on a boulder on the shore of the lake, stopped there for a few minutes, and then flew down along the valley. Besides, stray specimens were observed occasionally at *c.* 3800-4000 m during the spring.

***Haliastur indus** (Boddaert): Brahminy Kite

A few examples of the Brahminy Kite were seen in the Pilua Khola valley, about 10 km east of Chainpur at about 1370 m in late June.

Accipiter nisus melaschistos Hume: Indian Sparrow-Hawk

Khumbu: Bhote Kosi Valley: Hunko: 1 ♀ (17 March); Lobujya Valley; Phalong Karpo: 1 ♂ (23 April).

Measurements:	Wing	Tail	Bill
1 ♂:	209	163	19
1 ♀:	252	192+	23

Colours of bare parts: Iris golden yellow, cere lemon yellow, bill bluish slaty with black on tip (black more extensive in male), legs and feet chrome yellow, claws black.

The Sparrow-Hawk did not appear to be particularly common in eastern Nepal. Examples were sporadically seen at altitudes ranging between *c.* 3000 and 4570 m in spring.

My male specimen from Phalong Karpo is doubtfully placed under this subspecies. It is not in full adult plumage and is somewhat worn. It is a shade paler than the other examples of *melaschistos* I have examined, but not quite as pale as *nisosimilis*. Dr Charles Vaurie, who examined the specimen, writes (*in litt.*) 'that *nisosimilis* is not a very good race' as out of the hundreds that he has seen 'about 40 per cent . . . are not separable from nominate *nisus*'. He concludes that my specimen 'is either *A. nisus melaschistos* or *A. n. nisosimilis*'.

***Aquila chrysaetos** (Linnaeus): Golden Eagle

The Golden Eagle was sighted only on a few occasions in eastern Nepal between *c.* 1830 and 3050 m in January-February.

***Ictinaetus malayensis** (Temminck): Black Eagle

The Black Eagle was seen by me twice between Dolalghat and Risingo, central Nepal, at *c.* 850-1520 m late in January, and once in the Pilua Khola valley, about 12 km east of Chainpur, at *c.* 1400 m on 26 June.

***Icthyophaga nana** (Blyth): Greyheaded Fishing Eagle

The Greyheaded Fishing Eagle was seen by me once at Dolalghat (*c.* 850 m) on the Sun Kosi river, central Nepal, on 27 January; and thrice in Khumbu, eastern Nepal, twice below the Base Camp on the Dudh Kosi river, at about 3500 m between 4 and 8 May, and once a single bird flying down along the Dudh Kosi river between Karnassa and Nah at about 4250 m on 10 May.

The species does not seem to have so far been reported from as high an altitude as 3500 m.

***Torgos calvus** (Scopoli): Black Vulture

In eastern Nepal, the Black Vulture was observed by me once between Those and Chyangma at about 2130 m in the Khimti Khola valley, Ramechhāp district, on 4 February, and a few times between Khote and Chainpur (*c.* 610-1600 m), Dhankuta district, between 13 and 25 June

***Gyps himalayensis** Hume: Himalayan Griffon

The Himalayan Griffon appeared rather scarce in Khumbu. I saw it only on a few occasions around Namche Bazar, Base Camp and Thyangboche between 3800 and 4000 m in mid-February.

[Gypaetus barbatus aureus (Hablizl): Himalayan Lämmergeier

Khumbu: Bhote Kosi Valley: Paré: 1—(2 April).
Measurements: 1—: Wing 827, tail 512, bill 87.

The Lämmergeier or the Bearded Vulture was occasionally met with by us from *c*. 1830 to 5480 m and above in eastern Nepal. In Khumbu it was regularly seen almost every day, but there appeared to be only a few individuals there. It used to soar up and down along the various rivers, frequently crossing high ridges to get into the adjacent valleys. It was seen soaring above the Khumbu glacier, Gokyo and Thonak, Ngojumba glacier, as well as passing down along the Dudh Kosi river below Namche Bazar.

On 4 February a nest of this bird was found in a small cave on the cliff-face overlooking Those-Chyangma path at about 2135 m. The incubating parent bird was chased away and the single egg which formed the clutch was collected by a member of the expedition. Later, on 18 April, an aerie of the Lämmergeier was found a little to the northwest of Pangboche in a cave high up on a sheer cliff-face at about 4700 metres on Taweche ridge. The cliff-face below the mouth of the aerie was marked with long white streaks of droppings. During mid-April and early May, the Lämmergeier was occasionally seen to enter into and leave the aerie.

***Falco tinnunculus** Linnaeus: Kestrel

The Kestrel was occasionally seen by us in and around the cultivated fields near Chainpur in June.

Order CICONIIFORMES

Family Ciconiidae

***Leptoptilos dubius** (Gmelin): Adjutant

A pair was seen flying near Chainpur in the morning of 16 June.

Order ANSERIFORMES

Family Anatidae

***Anser indicus** (Latham): Barheaded Goose

On 5 April at about 12.15 hours we noticed from the Base Camp a flock of the Barheaded Goose flying from south to north over the Dudh Kosi river. The passage appeared smooth till the flock reached the confluence of the Imja Khola with the Dudh Kosi, where the birds seemed hesitant for a short while. Circling over the confluence for a few minutes the flock flew upwards above the Phorcha and Thyangboche buttresses, and changing course northwestward, disappeared into the mist along the Dudh Kosi valley which it apparently took.

Tadorna ferruginea (Pallas): Ruddy Sheld-duck or Brahminy Duck

Khumbu: Dudh Kosi Valley: Toujung Lake: 1♂ (15 May); Longbonga Lake: 1 (♂) (15 May).

Measurements: 2♂: Wing 378, 385; tail 135, 138; culmen 43·5, 46.

The Brahminy Duck was found in small numbers on the three lowermost lakes on the upper reaches of the Dudh Kosi, namely, Longbonga, Toujung and Dudh Pokhari (*c.* 4700-4900 m) between late February and mid-May.

The Toujung specimen had much enlarged testes. Obviously, the birds were getting ready to breed and preparing to leave for their breeding grounds, unless they bred locally.

Anas penelope Linnaeus: Wigeon

Khumbu: Dudh Kosi Valley: Longbonga Lake: 2♂ (11 May).

Measurements: 2♂: Wing 240+, 255++; tail 95, 102; bill 40, 42; culmen 33(2).

The Wigeon was observed in small numbers on the Longbonga Lake and Dudh Pokhari only in May. Furthermore, on 5 April at about 11 hours, a single male specimen of what appeared to be a Wigeon was seen from the Base Camp flying back and forth along the Dudh Kosi river between its confluence with the Imja Khola and a kilometre or so to the south. It looked as if the bird had lost its way and was trying to get its bearings. After two or three sorties north and south, it finally made off towards the south and was not seen to come back.

Both my specimens had enlarged gonads.

The primaries are worn in both the specimens, more so in one of them. In that specimen the tail is in moult—the two central pairs of rectrices are fresh, while the other tail-feathers are very worn.

The two Khumbu specimens differ somewhat in the details of coloration. Thus, one of them has the head, neck, chin and throat slightly paler than those of the other specimen. Also, it has very few black spots on the lores and the sides of the head, and it lacks the blackish vermiculations on the upper breast, which are conspicuous in the other specimen. This latter bird has the buff on the forehead and crown very much paler than in the other bird—almost of cream colour.

Aythya fuligula (Linnaeus): Tufted Duck

Khumbu: Dudh Kosi Valley: Longbonga Lake: 1♂ (11 May).

Measurements: 1♂: Wing 198+, tail 55, bill 48, culmen 41.

Colours of bare parts: Iris bright yellow, bill slaty with black on tip and lower mandible, legs and feet slaty olive, claws black.

The Tufted Duck was seen by us in very small numbers on the Longbonga Lake and Dudh Pokhari in May.

The two outermost pairs of primaries in my specimen are somewhat worn, and the rectrices are fresh, except the central pair which is only half-grown and has sheath on base.

Order GALLIFORMES

Family Phasianidae

***Lerwa lerwa** (Hodgson): Snow Partridge

The Snow Partridge was observed by me only twice in Khumbu, once on the lateral moraine of the Khumbu glacier at about 5000 m on 20 February, and again above the track near Koner (a kilometre or so to the northwest of Phorcha), Dudh Kosi valley, on 10 May. It was, however, heard more frequently in March and May than seen. The highest elevation at which it was encountered was about 5200 m on 31 March, when it was heard near the crest of the ridge separating the Langmoche and Thami valleys between Langmoche and Gnachu.

Tetraogallus tibetanus aquilonifer R. & A. Meinertzhagen: Sikkim Snowcock.

Khumbu: Bhote Kosi Valley: Marlung: 2 ♂ (10 March); Thami Valley: Gnachu: 1 ♂ (24 March); Thyangbo: 1 ♂, 1 ♀ (24 March).

Measurements:

	Wing	Tail	Bill
4 ♂:	267, 268, 270, 271	161, 162, 163, 164	37·5, 38·5, 39 (2)
1 ♀:	265	158	36

Colours of bare parts: Iris dark brown, edges of upper eyelid orange, edge of lower eyelid, postorbital skin, cere and nasal membrane reddish orange, bill dusky orange-yellow, legs and feet reddish orange, claws black.

The Snowcock was not uncommon in Khumbu in groups of two to six or so on moraines, sparsely scrubby or grass-covered rocky areas, etc. between *c.* 4700 and 5335 metres during February-May. Strangely enough, it appeared to be fairly common and quite at home on the snow-covered moraines of the Khumbu glacier at *c.* 5180-5335 metres in February!

The gonads of the Thami Valley (Gnachu and Thyangbo) specimens were moderately enlarged, the male from Gnachu having 16×10 (right) and 15×8 (left) testes, and that from Thyangbo having them 10×6 (right) and 14×7 (left); and the female from Thyangbo having a coarsely granular ovary, the largest ovum being about 3 mm in diameter.

The extent of dark grey on the base of the throat in the males is somewhat variable in my specimens. Thus, it is in two small irregular patches in the Gnachu male, while it is in the form of an almost complete band with a little gap in the three other males, much like the Sikkim birds described by Rand & Fleming (1957, p. 59). The female has the chin and anterior throat white, while the malar region, posterior throat and anterior breast are brownish black mottled with light buff and white.

***Francolinus francolinus** (Linnaeus): Black Partridge

The Black Partridge was heard only once in eastern Nepal, below Kirantichhāp, at about 1000 m, in Ramechhāp district, on 31 January.

Ithaginis cruentus cruentus (Hardwicke): Nepal Blood Pheasant

Khumbu: Dudh Kosi Valley: Base Camp: 1 ♂, 1 ♀ (7 April); Imja Valley: Yaral: 1 ♀ (3 May).

Measurements:

	Wing	Tail	Bill
1 ♂:	207	157	27·5
2 ♀:	190, 205	130, 159	24·5, 25

Colours of bare parts: *Male*: Iris brown; orbital skin, cere and nasal membrane orange-vermilion; bill black with coral red on base and gape; legs, feet and pads coral red; claws dark horny on top but pale orange on underside. *Female*: Similar to male but orbital skin dull orange, cere black anteriorly but orange posteriorly, nasal membrane black, bill black all over, legs and feet coral red with a dusky tinge specially on feet.

We found the Blood Pheasant to be fairly common in Khumbu between *c*. 3800 and 4100 m during February-May. It occurred in small parties in forests consisting of rhododendrons, birch and fir, and did not appear to be particularly shy.

Tragopan satyra (Linnaeus): Crimson Horned Pheasant

Solu: Dudh Kosi Valley: Ghat: 1 ♂, 1 ♀ (29 April, 16 May).

Measurements:

	Wing	Tail	Bill
1 ♂:	272	253	31
1 ♀:	235	184	30·5

Colours of bare parts: *Female*: Iris brown, bill horny brown, legs and feet reddish brown, claws horny.

The Crimson Horned Pheasant was seen between *c*. 2750 and 3050 metres in the Dudh Kosi valley above Ghat and Phakding in April and May, and above Bung (*c*. 2740 m) in the Hongu Valley, early in June.

The specimens listed above were caught alive in Ghat area by some local people and brought to the Base Camp for the Expedition's menagerie. The female bird, after it was caught, remained with the catcher for some days when it was said to have laid three eggs. It was then brought to our camp where it lived only for a few days and died on the morning of 29 April. The male bird lived in the menagerie for a week and died on 16 May morning.

The male specimen had well-developed testes, but the female had an exhausted ovary.

Lophophorus impejanus (Latham): Monal Pheasant

Khumbu: Bhote Kosi Valley: Hunko: 2 ♂, 1 ♀ (17, 19 March); Thami Valley: Thami: 1 ♂ (19 March).

Measurements:

	Wing	Tail	Bill
3 ♂:	292, 294, 301	203+, 222+, —	52 (2), —
1 ♀:	270	—	47

Colours of bare parts: Iris dark brown, orbital skin bright blue (paler in the female), bill dark horny, legs and feet olive horny, claws horny.

The Monal Pheasant was found to be common in small parties in Khumbu between *c.* 3800 and 4270 m in forests during February-May.

The tips of rectrices are somewhat worn in the Thami male (19 March), and very much so in the female from Hunko (17 March).

The Thami male has still retained some juvenile characters. It has rufous barrings on the outer two secondaries, partial barrings on the inner four secondaries, and dark brown and white mottling on the bases of rectrices, the two outermost pairs of which are extensively marked with black bars and spots.

Compared with the winter-taken female specimens from northern Sikkim, the only female from Khumbu has somewhat reduced white on the chin and throat, and has slightly paler, less rufous bars on the secondaries.

The gonads of the Khumbu specimens had already started swelling.

***Lophura leucomelana** (Latham): Kalij Pheasant

The Kalij Pheasant was seen late in the afternoon of the 7th February near Taksindhu at about 3050 m (*c.* 27°37′N, 86°38′E, Okhaldhunga district), that is, on the ridge separating the Solu Khola from the Dudh Kosi. Later, on 25 May, it was seen in a pair early in the afternoon feeding in a harvested field on a ledge about 50 m below Namche Bazar, that is at about 3750 m. I was informed by some local people that this pair of birds regularly came there late in the day. Next day (26 May), I saw the pair again there feeding at about 11 a.m.

Order CHARADRIIFORMES

Family Charadriidae

Subfamily Charadriinae

***Vanellus duvaucelii** (Lesson): Spurwinged Plover

A few individuals of the Spurwinged Plover were observed on the bank of the Arun river between Sati Ghat and Tumlingtar at *c.* 450 m altitude on 11 and 12 June.

Subfamily Scolopacinae

***Numenius arquata** (Linnaeus): Curlew

Dr William Edgar, Medical Officer of the Expedition, who has a good knowledge of the British birds, reported to me that he had heard the Curlew on the Khumbu glacier at about 5300 m early in May. He was not, however, lucky enough to view the bird.

***Tringa hypoleucos** Linnaeus: Common Sandpiper

A few specimens of the Common Sandpiper were sighted singly on the edges of both the Indrawati and Sun Kosi rivers near their confluence at Dolalghat (alt. *c.* 850 m ; 27°38′N, 85°43′E) on 27 January.

***Scolopax rusticola** Linnaeus: Woodcock

On 2 April, at dusk, two specimens of the Woodcock were seen separately, flying slowly and somewhat irregularly over the forest to the east of the Base Camp, uttering feeble squeaks at the same time. They were observed to proceed as far as the head of a small hill stream and could not be traced any further owing to bad visibility. The same performance was repeated at the same time on 3 and 4 April. I am not sure if they were 'roding'.

Subfamily Ibidorhynchinae

***Ibidorhyncha struthersii** Vigors: Ibisbill

A party of five Ibisbills was observed on 27 January at Dolalghat on the shingle banks at the confluence of the Indrawati and Sun Kosi rivers. The birds did not appear to be shy and permitted prolonged observation by most members of the Expedition from fairly close range.

Family Laridae

***Sterna aurantia** J. E. Gray: Indian River Tern

The Indian River Tern was seen only once by me at Sati Ghat on Arun river (alt. *c*. 460 m ; 27° 21′N, 87°12′E) on 11 June, when a few birds were scanning the river at about midday.

***Sterna acuticauda** J. E. Gray: Blackbellied Tern

Small numbers of the Blackbellied Tern were observed on the Arun river from Sati Ghat to Tumlingtar (alt. *c*. 305-460 m) on 11 and 12 June.

Order COLUMBIFORMES

Family Columbidae

***Treron sphenura** (Vigors): Wedgetailed Green Pigeon

A party of four examples, and another of six, of the Wedgetailed Green Pigeon were noticed on *Ficus* trees near Khoté (alt. *c*. 915 m ; 27°16′N, 87°14′E), Sabhaya Valley, Dhankuta district, eastern Nepal, on 11 June.

Columba leuconota leuconota Vigors: Snow Pigeon

Khumbu: Bhote Kosi Valley: Thammu: 1 ♀ (7 March); Thami Valley: Thami: 1 ♂ (8 March).

Measurements:

	Wing	Tail	Bill
1 ♂:	254	137	25
1 ♀:	237	131	22

Colours of bare parts: Iris golden yellow, bill black, legs and feet cherry red, claws black.

The Snow Pigeon was first seen during this Expedition on 7 February in a large flock above Junbesi (*c*. 27°34′N, 86°33′E) in the Beni Valley, Solu, at about 3000 m. It was later observed at different places in Solu in large flocks between *c*. 2895 and 3050 m up to 10 February. In Khumbu it was seen from mid-February to April between *c*. 3655 and 4400 m in and about all the villages, but never in large flocks: it occurred there in small flocks of about a dozen birds at the most, and in late April, even in pairs.

Compared with the northern Sikkim examples taken in January, these Khumbu specimens have much duller head and wing-coverts, and browner mantles. I have not, however, been able to compare these specimens with examples from the western Himalaya.

Streptopelia orientalis agricola (Tickell): Eastern Turtle Dove

Khumbu: Dudh Kosi Valley: Below Khumjung: 1 ♂ (9 April).

Measurements: 1 ♂: Wing 190, tail 139, bill 21.

Colours of bare parts: Iris orange-red; orbital skin, edges of eyelids, cere and base of bill purplish crimson; bill pale horny; legs and feet crimson; claws horny.

The Eastern Turtle Dove was rather scarce in Khumbu. None was seen there until April 9, presumably because none had returned from the winter quarters. Subsequently, it was seen in one or two pairs at a time only at a few localities, such as near Thyangboche (*c*. 3960 m) on 17 April and 4 May, below Phorcha (*c*. 3950 m) on 9 May, and Phakding on 28-30 May. Later and further southeastward in the Arun watershed about Chainpur, it appeared commoner. There many pairs were found between 13 and 25 June on the edges of forests.

Order PSITTACIFORMES

Family Psittacidae

***Psittacula himalayana** (Lesson): Himalayan Slatyheaded Parakeet

The Himalayan Slatyheaded Parakeet was seen only once in a small flock at an altitude of about 1100 metres in a forest between Manga Deorali and Kirantichhāp, Ramechhāp district, on 31 January.

Order CUCULIFORMES

Family Cuculidae

***Cuculus sparverioides** Vigors: Large Hawk-Cuckoo

The Large Hawk-Cuckoo was heard only in the Arun watershed at about 1525 m altitude between Pokhara and Dingla, Bhojpur district, on 8-10 June.

***Cuculus micropterus** Gould: Indian Cuckoo

The Indian Cuckoo was heard and seen several times between 13 and 25 June about Chainpur, Dhankuta district.

***Cuculus canorus** Linnaeus: Cuckoo

The Cuckoo was first heard in Khumbu by me on 10 May near Phorcha. It was subsequently observed or heard between *c*. 3650 and 4260 m up to the last week of May when I left Khumbu. It was not particularly common there. Elsewhere in eastern Nepal, it appeared to be common between *c*. 1220 and 2745 m from the Hongu Valley east to the Tamur Valley in June.

***Cuculus saturatus** Blyth : Himalayan Cuckoo

This cuckoo seemed common in the Solu region, Dudh Kosi Valley (Puiyan, Phakding, etc.) eastward to the Tamur Valley, between *c.* 1525 and 3050 m from end May to end June.

***Eudynamys scolopacea** (Linnaeus): Koel

The Koel was observed and heard only about Dingla (*c.* 1525 m) in the Arun Valley, Khoté (*c.* 915 m) in the Sabhaya Valley, and in the Hinwan Valley at *c.* 1370 m, below Chainpur, between 9 and 25 June.

Order CAPRIMULGIFORMES

Family Caprimulgidae

Caprimulgus indicus hazarae Whistler & Kinnear: Himalayan Jungle Nightjar

Okhaldhunga district: Inukhu Valley: *c.* 9 km E of Pankhoma: 1—[in alcohol] (2 June).

Measurements: 1—: Wing 207, tail 140, bill from posterior edge of nostril 9.

This specimen was found lying dead on the edge of a forest path at about 10 in the morning. Rigor mortis had not set in when it was found, and it had no visible mark of injury on its body.

Some nightjars, probably the Jungle Nightjars, were heard at Chiya Kharka (*c.* 3050 m), Inukhu Valley, and at Bung (*c.* 2700 m), Hongu Valley, early in June.

Order CORACIIFORMES

Family Coraciidae

***Coracias benghalensis** (Linnaeus): Roller

The Roller was met with in very small numbers only around Tumlingtar (*c.* 305 m), Arun Valley, and near Khoté (*c.* 915 m), Sabhaya Valley, both in Dhankuta district, on 11 and 12 June.

Family Upupidae

Upupa epops saturata Lönnberg: Tibetan Hoopoe

Khumbu: Pumori glacier (*c.* 5700 m; 28°N, 86°50′E): 1—[in alcohol] (7 May).

Measurements: 1—: Wing 153·5, tail 102, bill 65.

The only specimen of the Tibetan Hoopoe encountered by us was shot by Mr T. Stobart of the Expedition in an ablation valley of the Pumori glacier.

The Tibetan Hoopoe has earlier been reported from the adjacent areas of Tibet and Sikkim as high as *c.* 4572-6400 metres by Wollaston and Blanford (in Kinnear, 1922, p. 204). Diesselhorst (1968, p. 174) and Martens (1971a, p. 122) have reported it from Khumbu between 3800 and 5000 metres.

Order APODIFORMES

Family Apodidae

***Apus pacificus** (Latham): Whiterumped Swift

The Whiterumped Swift was observed on several occasions flying about in small flocks over the Dudh Kosi river near the Base Camp at *c.* 3600-3800 m in April-May. It was also seen in Chainpur area (*c.* 1525 m) in mid-June.

Apus affinis (J. E. Gray): House Swift

The House Swift was common in Chainpur in mid-June.

Order PICIFORMES

Family Capitonidae

***Megalaima virens** (Boddaert): Great Himalayan Barbet

The Great Himalayan Barbet was found practically all over eastern Nepal between *c.* 1500 and 1830 m in June and early July. It was, however, more often heard than seen.

***Megalaima franklinii** (Blyth): Goldenthroated Barbet

This barbet did not appear to be common in eastern Nepal. It was observed on a few occasions between Pokhara and Dingla, Bhojpur district, on 8 June, and about Chainpur between 13 and 25 June.

Family Picidae

***Picoides auriceps** (Vigors): Brownfronted Pied Woodpecker

Many pairs of the Brownfronted Pied Woodpecker were observed in a pine forest a little below Manga Deorali (*c.* 1830 m; 27°40′N, 85°57′E), Ramechhāp district, on 31 January. Diesselhorst (1968, p. 186) has recorded it further eastward, at 86°4′E, in the same district.

Order PASSERIFORMES

Family Alaudidae

Calandrella acutirostris tibetana Brooks : Brooks's Short-toed Lark

Khumbu : Lobujya Valley : Phalong Karpo : 1 ♀ (6 May) ; Imja Valley: above Pangboche (*c.* 4700 m) : 1—[in alcohol] (16 May).

Measurements :

	Wing	Tail	Bill
1 ♀ :	86	54	13·5
1— :	90	59	14

Colours of bare parts : Iris dark brown, bill orange-horny with blackish on culmen and tip, legs horny brown, feet and claws horny.

This short-toed lark was found in small numbers in the scrub about Phalong Karpo and above Pangboche in May.

The Phalong Karpo specimen is in a somewhat worn plumage, but the other one is fairly fresh.

Family Hirundinidae

***Hirundo daurica** Linnaeus : Striated Swallow

The Striated Swallow was common in June in most of the larger villages of eastern Nepal situated between *c.* 1525 and 2440 m.

***Delichon nipalensis** Moore : House Martin

Small numbers of the House Martin were observed in Chainpur area in mid-June.

Family Motacillidae

Anthus roseatus Hodgson : Hodgson's Pipit

Khumbu : Lobujya Valley : Pheriche-Phalong Karpo (*c.* 4300-4570 m) : 3 ♂♂, 2 ♀, 1—[in alcohol] (22-26 April) ; Dudh Kosi Valley : Longbonga Lake : 1 ♀ (11 May).

Measurements :

	Wing	Tail	Bill
3 ♂ :	89, 90·5, 94	66, 69, 73	16, 16·5, —
3 ♀ :	81·5, 83·5, 84	59, 62 (2)	16 (2), —
1— :	89	65	16·5

Colours of bare parts : Iris dark brown, bill horny black but fleshy horny on lower mandible, legs and feet fleshy brown, claws horny.

In mid-February when I camped in the Pheriche-Phalong Karpo area, not a single example of the Hodgson's Pipit was seen there, but when I revisited the area between 22 and 29 April, it was quite common there. It occurred in small parties which were breaking up into pairs. It was usually feeding on the damp ground near the large numbers of streamlets that criss-cross the area, and when alarmed was hiding in the dwarf alpine vegetation. Its behaviour and the somewhat swollen condition of the gonads suggested that it was getting ready to breed. It was also found equally common in small parties or pairs in a western ablation valley of the Ngojumba glacier, especially on the shores of the Longbonga and Gokyo lakes (*c.* 4700-4900 m) between 11 and 15 May.

Motacilla alba alboides Hodgson : Hodgson's Pied Wagtail

Khumbu : Lobujya Valley : between Phalong Karpo and Thugla (*c.* 4600 m): 1 ♂, 1 ♀ (24 April) ; Thami Valley : Thami : 1—(18 March).

Measurements :

	Wing	Tail	Bill
1 ♂ :	97	89+	18·5
1 ♀ :	90	90	18
1— :	92	90	—

Colours of bare parts : Iris dark brown ; bill, legs, feet and claws black.

Hodgson's Pied Wagtail was found from time to time during my march eastward from Kathmandu, especially about Banepa, Lamadihi, Dolalghat, Chyaubas and the Khimti Valley between 850 and 2150 m. In Khumbu, it appeared rather rare from mid-February to early April. From mid-April onwards, it was quite common in pairs, one chasing the other, with characteristic undulating flight, and uttering a rather musical note. In the Pheriche-Phalong Karpo area, it occurred generally on the larger streams up to a little below Thugla (*c.* 4700 m).

Family Campephagidae

***Pericrocotus flammeus** (Forster): Scarlet Minivet

A flock of the Scarlet Minivet (males) was seen between Lamadihi and Dolalghat (*c.* 850-1050 m), Chautara district, on 27 January.

Pericrocotus ethologus favillaceus Bangs & Phillips: Longtailed Minivet

Khumbu : Bhote Kosi Valley : Paré (*c.* 4000 m) : 1 ♂ [in alcohol] (1 April).

Measurements : 1 ♂ : Wing 93, tail 110, bill 16.

Colours of soft parts : Iris dark brown ; bill, legs, feet and claws black.

The Longtailed Minivet was first observed by us on 8 February below Taksindhu (*c.* 1980 m), Dudh Kosi Valley. It occurred in a mixed flock of males and females. The only other occasion when we found it was above Paré in Khumbu, and only two pairs were seen there.

Family Pycnonotidae

Pycnonotus leucogenys leucogenys (J. E. Gray): Whitecheeked Bulbul

Dhankuta district: Chainpur: 1 ♀, 1— [in alcohol] (19 June).

Measurements:

	Wing	Tail	Bill
1 ♀:	85	80	19
1—:	91	85	—

Colours of bare parts: Iris dark brown; bill, legs, feet and claws black.

The Whitecheeked Bulbul was found from time to time during our eastward march, especially in the Khimti Valley (*c.* 1800 m) in early February, and in the Arun, Sabhaya and Tamur Valleys (*c.* 600-1800 m) in June.

***Pycnonotus cafer** (Linnaeus): Redvented Bulbul

The Redvented Bulbul was seen by us between Banepa and Risingo (*c.* 1370-1520 m), Chautara district, during late January, and again in the Tamur Valley, Dhankuta district, up to *c.* 1500 m in June.

***Hypsipetes madagascariensis** (P. L. S. Müller): Black Bulbul

The Black Bulbul was found in flocks near Manga Deorali (*c.* 2400 m), Chautara district, on 30 January, and between Tamba Kosi and Khimti valleys, Ramechhāp district, at *c.* 1500-2000 m in early February.

Family Laniidae

Lanius tephronotus tephronotus (Vigors): Tibetan Shrike

Khumbu: Imja Valley: Dingboche: 1 ♂ (20 April). Solu: Dudh Kosi Valley: Phakding: 1 ♂, 1— [in alcohol] (27, 28 May).

Measurements:

	Wing	Tail	Bill
2 ♂:	98·5+, 103	120, —	21, 22·5
1—:	101	—	22

Colours of bare parts: Iris dark brown; bill black (slaty on base in a male); legs, feet and claws black.

We did not find the Tibetan Shrike to be common in eastern Nepal. It was encountered only once in Khumbu, on 20 April, when the specimen was taken. During late May, however, it appeared somewhat commoner in the Ghat-Phakding area of Solu.

The gonads of the Khumbu specimen (20 April) were but slightly developed, while they were fully developed in the male collected at Phakding on 27 May.

The Phakding specimens are in somewhat worn plumage.

Family Cinclidae

Cinclus pallasii tenuirostris Bonaparte : Brown Dipper

Khumbu: Confluence of Dudh Kosi river and Imja Khola (*c.* 3650 m ; 27°50′N, 86°45′E) : 1 ♂ (3 April).

Measurements : Wing 103, tail 62·5, bill 23·5.

Colours of bare parts : Iris brown, bill black, legs and feet pale bluish slaty, pads yellowish grey.

The Brown Dipper was first sighted by us on Khimti Khola at Those (*c.* 1830 m), Ramechhāp district on 4 February. Later, it was seen in Khumbu on several occasions, sometimes in pairs, on Imja Khola, specially about its confluences with the Dudh Kosi and Lobujya Khola, during February-May between *c.* 3650 and 4570 m.

The testes of the specimen were slightly enlarged.

Family Troglodytidae

Troglodytes troglodytes kinneari Biswas: Kinnear's Wren

Khumbu : Bhote Kosi Valley : Thammu : 1 ♂ [Holotype] (7 March).

Measurements : 1 ♂ : Wing 54, tail 34, bill 9.

Colours of bare parts : Iris dark brown ; bill, legs, feet and claws dark horny.

The Kinnear's Wren was observed in Khumbu during February-May between *c.* 2740 and 3660 m. It occurred singly among boulders forming boundaries of agricultural fields.

Vaurie (1959, p. 205), Ripley (1961, p. 538) and Ali & Ripley (1973, p. 137) have treated *T. t. kinneari* Biswas as a synonym of *T. t. nipalensis* Blyth.

Family Prunellidae

Prunella collaris nipalensis (Blyth) : Eastern Alpine Accentor

Khumbu : Dudh Kosi Valley : Thonak : 1 ♂ (8 April), Base Camp : 1 ♀ (1 March) ; Bhote Kosi Valley : Thammu : 1— [in alcohol] (7 March) ; Ngojumba Valley : Chugima : 2 ♂ (14 May).

Measurements :

	Wing	Tail	Bill
3 ♂ :	97, 99, 103·5	65, 69, 71	16(2), 16·5
1 ♀ :	100	72	16
1— :	97	69	16

Colours of bare parts : Iris dark brown, bill black with yellow on base, legs and feet fleshy brown (March) or brownish orange (April-May), claws black, pads greyish yellow.

In eastern Nepal, the Alpine Accentor was found only in Khumbu. It did not appear to be particularly common there, occurring generally singly in scrub. During late February to early April, it appeared rather scarce and shy, but later it was bolder and was seen in larger numbers.

The April male specimen from Thonak had its gonads somewhat enlarged, but those from Chugima taken on 14 May had well-developed testes.

The white fringing of the flank feathers is rather variable in the Khumbu birds. Thus, the male from Thonak and one of the males from Chugima have mere traces of white on the flank feathers, but the female taken at the Base Camp area has somewhat more extensive white fringes on the flank feathers, and its central abdominal feathers are also fringed with white. The other male from Chugima has, however, no white on the flanks. The chestnut in the Khumbu birds is much deeper than in my only Sikkim bird (♂, Lachung, 3050 m, 22 January 1953). The Sikkim bird has, however, as much white on its underside as in the Khumbu female.

Prunella strophiata strophiata (Blyth): Rufousbreasted Accentor

Khumbu: Lobujya Valley: Phalong Karpo: 1 ♂ (23 April); Thugla, 1 ♂ (24 April); between Phalong Karpo and Thugla (*c.* 4650 m): 1 ♂ (26 April); Imja Valley: Yaral: 1 ♂, 1 — (30 April).

Measurements:

	Wing	Tail	Bill
4 ♂:	62, 66, 68, 70	53, 57, 58, 61·5	— (4)
1 —:	66	56·5	—

Colours of bare parts: Iris reddish brown, bill black (once with brownish on base), legs and feet brownish fleshy, claws horny.

A confiding bird, the Rufousbreasted Accentor was not uncommon in Khumbu between *c.* 3650 and 4930 m during February-May.

The gonads of the Phalong Karpo and Thugla specimens were somewhat enlarged.

Prunella rubeculoides rubeculoides (Moore): Robin Accentor

Khumbu: Thami Valley: Thami: 1 ♂ (17 March); Imja Valley: Dingboche: 2 ♀ (19 April).

Measurements:

	Wing	Tail	Bill
1 ♂:	73	62	—
2 ♀:	77, 78	65, 66	14, —

Colours of bare parts: Iris reddish brown, bill black, legs and feet light (March) to orange (April) brown, claws dark horny to black.

The Robin Accentor was found in Khumbu in small numbers between *c.* 3960 and 4930 m during February-May, frequenting scrub and feeding generally on the ground.

The male specimen (mid-March) had undeveloped testes, but the females (mid-April) had granular ova.

The rufous brown streaks on the dorsal side of the March specimen are more rufous than those of the other specimens, and the ferruginous on its breast is also deeper. The differences in coloration may possibly be due to the state of wear, the Thami male (17 March) being in very fresh plumage, while the other two (19 April) are slightly worn.

Family Muscicapidae

Subfamily Turdinae

Erithacus pectoralis confusus (Hartert): Eastern Rubythroat

Khumbu: Lobujya Valley: Phalong Karpo: 3 ♂ (22, 23, 29 April); Ngojumba Valley: Chugima: 1 ♀ (14 May).

Measurements:

	Wing	Tail	Bill
3 ♂:	76, 77, 79	64, 64·5, —	17, — (2)
1 ♀:	67	55	—

Colours of bare parts: Iris dark brown; bill, legs, feet and claws black (legs in ♀ dark horny).

The Eastern Rubythroat was sighted and collected in the Lobujya and Ngojumba Valleys of Khumbu between *c.* 4570 and 4850 m in April-May. It occurred among boulders of moraines and in scrub on the ground, but appeared to be rather uncommon.

Two of the male specimens taken on 22 and 23 April had enlarged testes, but in the one collected on 29 April they had just commenced swelling, and the female (14 May) had an ovary that appeared to be spent.

Erithacus cyanurus rufilatus (Hodgson): Redflanked Bush Robin

Khumbu: Bhote Kosi Valley: Paré (*c.* 3900-4000 m): 2 ♂ (25 March, 1 April); Imja Valley: Yaral: 3 ♂, 1 ♀ (30 April, 1 May); Pangboche: 1 (♀) [in alcohol] (29 April).

Measurements:

	Wing	Tail	Bill
4 ♂:	82, 83 (3)	65, 66, 67, —	— (4)
2 ♀:	78, 79	60, 62	15, —

Colours of bare parts: Iris dark brown; bill, legs, feet and claws black.

The Redflanked Bush Robin occurred in Khumbu in scrub and bushes in small numbers during late March and early April, but about a month later, that is during late April and May, it was commoner there.

Three of my male specimens (1 April, 30 April) and a female (1 May) had fully developed gonads.

Erithacus chrysaeus chrysaeus (Hodgson): Golden Bush Robin

Khumbu: Imja Valley: Yaral: 1 ♂ (30 April), 1 ♀ (3 May).

Measurements:

	Wing	Tail	Bill
1 ♂:	66·5	55	14·5
1 ♀:	66	54	—

Colours of bare parts: Iris dark brown; bill black with golden yellow on lower mandible and sides of upper mandible (♂) or golden yellow on base of lower mandible and dusky on its anterior half (♀); legs and feet brown but golden yellow showing through; claws horny; pads yellow.

The Golden Bush Robin appeared rather rare in Khumbu: we did not see any there till late in April, and then also rarely and under thick bushes.

The gonads of both my specimens were somewhat enlarged.

Erithacus indicus indicus (Vieillot): Whitebrowed Bush Robin

Khumbu: Imja Valley: Yaral: 1 ♂ (1 May).

Measurements: 1 ♂: Wing 80, tail 66, bill 16.

Colours of bare parts: Iris dark brown; bill black; legs, feet and claws very dark horny.

The Whitebrowed Bush Robin appeared very scarce in Khumbu. It was spotted there only once in scrub, when it was collected.

Copsychus saularis saularis (Linnaeus): Indian Magpie-Robin

Dhankuta district: Chainpur: 1 ♂ (19 June).

Measurements: 1 ♂: Wing 97, tail—, bill 20.

Colours of bare parts: Iris dark brown; bill, legs, feet and claws black.

The Indian Magpie-Robin was common during January-July from the Nepal Valley east to the Singalila ridge on the Indian frontier up to about 1550 m altitude in and about towns and villages, in orchards, and in light forests.

Phoenicurus frontalis (Vigors): Bluefronted Redstart

Khumbu: Thami Valley: Thami: 1 ♂ [in alcohol] (18 March); Bhote Kosi Valley: Hunko: 1 ♂ (25 March); Imja Valley: Dingboche: 1 ♂ (20 April), 1 ♀ (18 April), Yaral: 2 ♂ (1, 2 May).

Measurements:

	Wing	Tail	Bill
5 ♂:	84, 85, 86 (2), 91	65, 68 (2), 73, —	15·5 (2), 16 (3)
1 ♀:	79	61	15

Colours of bare parts: Iris dark brown; bill, legs, feet and claws black.

The Bluefronted Redstart was quite a common bird during winter and spring from the Nepal Valley east to Okhaldhunga district up to about 4950 m altitude.

Two of the male specimens, taken on 25 March and 20 April, had their testes somewhat enlarged, but two other males (1 and 2 May) and the female (18 April) had fully developed gonads.

Phoenicurus schisticeps (G. R. Gray): Whitethroated Redstart

Khumbu: Dudh Kosi Valley : Tesinga : 1 ♂ (6 March) ; Bhote Kosi Valley : Phurte : 1 ♂ (7 March).

Measurements : 2 ♂ : Wing 85, 87 ; tail 70, 72 ; bill 16, 16·5.

Colours of bare parts : Iris dark brown ; bill, legs, feet and claws black.

The Whitethroated Redstart was found in Khumbu during March only, occurring in small numbers in scrub and bushes between *c.* 3600 and 4000 m.

Rhyacornis fuliginosus fuliginosus (Vigors): Plumbeous Redstart

Solu : Dudh Kosi Valley : Phakding : 1 ♂ (29 May).

Measurements : 1 ♂ : Wing —, tail —, bill 14.

Colours of bare parts : Iris dark brown; bill black; legs and feet brownish horny; claws black; pads white.

The Plumbeous Redstart was frequently found singly on boulders and shingle in the beds of streams of eastern Nepal during January-May between *c.* 900 and 4250 m altitude. In Khumbu, however, it did not appear to be particularly common.

The testes of the present specimen were fully enlarged.

Its plumage is very worn, specially the wing and tail.

***Grandala coelicolor** Hodgson : Hodgson's Grandala

A flock of the Hodgson's Grandala was seen twice in Khumbu, off Namche Bazar near the bend of the Dudh Kosi river, on 11 and 14 February. There were perhaps 50 birds in the flock which circled above the valley and from time to time alighted somewhere in the gorge below.

***Enicurus scouleri** Vigors : Little Forktail

The Little Forktail was seen by us only once in eastern Nepal, on Khimti Khola near Those, Ramechhāp district, on 4 February at *c.* 1830 m.

***Enicurus maculatus** Vigors : Spotted Forktail

We found the Spotted Forktail only once on a little stream (a tributary of the Chaunri Khola) below Manga Deorali, Chautara district, at *c.* 1525 m on 30 January.

***Saxicola torquata** (Linnaeus): Collared Bush Chat

The Collared Bush Chat was sporadically seen singly in bushes about cultivated fields between 26 January and 5 February in Chautara and Ramechhāp districts.

***Saxicola ferrea** G. R. Gray : Dark Grey Bush Chat

The Dark Grey Bush Chat was sighted once in the Bhota Kosi valley, Ramechhāp district, on 1 February at about 1220 m—a single bird perched on the top of a shrub.

Chaimarrornis leucocephalus (Vigors) : Whitecapped Redstart

Khumbu : Lobujya Valley : between Thugla and Phalong Karpo (*c.* 4650 m) : 1 ♂ (24 April), Pheriche : 1 ♂ (24 April) ; confluence of Lobujya and Imja Kholas (*c.* 4200 m ; 27°53′N, 86°49′E) ; 1 ♂ (25 April).

Measurements : 3 ♂ : Wing 100, 101, 102 ; tail 77, 81, — ; bill 17·5, 18 (2).

Colours of bare parts : Iris dark brown ; bill, legs, feet and claws black.

A few individuals of the Whitecapped Redstart were seen on Khimti Khola at about 1830 metres altitude near Those, Ramechhāp district, on 4 February. In Khumbu, it appeared common in pairs in the larger streams, such as Lobujya, Imja, Jambur and Chola Kholas, during April-May. A single example was also seen between Gokyo and Thonak Lake at *c.* 4950 m on 13 May.

The gonads of the specimens listed above were somewhat enlarged.

Myiophoneus caeruleus temminckii (Vigors) : Himalayan Whistling Thrush

Khumbu : Thami Valley : Thami : 1 ♂ (25 March) ; Dudh Kosi Valley : Nah : 1 ♂ (10 May) ; Bhote Kosi Valley : Paré : 1 ♀ (29 March). Solu : Dudh Kosi Valley : Phakding : 1 ♀ (28 May).

Measurements :

	Wing	Tail	Bill
2 ♂ :	173, 180 +	131, 135 +	34, 34·5
2 ♀ :	172, 173	126 +, 128	33, 34·5

Colours of bare parts : Iris dark brown ; bill yellow with black on culmen and base of upper mandible ; legs, feet and claws black.

The Himalayan Whistling Thrush was heard in Solu between Taksindhu and Kharikhola, Dudh Kosi Valley, at *c.* 1830 m on 8 February. In Khumbu it was found singly from time to time during March-May on Thami, Dudh Kosi and Bhote Kosi rivers between *c.* 3800 and 4400 metres; and was once seen on a boulder in the bed of the Dudh Kosi a little to the north of Toujung Lake at *c.* 4800 m for a few minutes on 15 May. It appeared rather silent in Khumbu. Later, it was found breeding in Solu at *c.* 3000 m late in May, and in June and early July further eastward up to the Singalila Ridge fairly commonly and frequently giving out its characteristic musical call.

The March specimens had somewhat enlarged gonads ; the male taken on 10 May had fully developed testes, while the female of 28 May had already laid and had incubation patches present.

***Zoothera mollissima mollissima** (Blyth): Eastern Plainbacked Mountain Thrush

Khumbu: Dudh Kosi Valley: Base Camp: 1 ♂, 1 ♀ (5 April).

Measurements:

	Wing	Tail	Bill
1 ♂:	149	104	27
1 ♀:	136	114	27·5

Colours of bare parts: Iris dark brown, bill dark horny, legs and feet wax yellow, claws pale horny.

This mountain thrush appeared scarce in Khumbu. It was seen singly only on a few occasions during April-May between *c.* 3650 and 3960 m.

The gonads of these two specimens were somewhat enlarged.

Turdus boulboul (Latham): Greywinged Blackbird

Okhaldhunga District: Hongu Valley: above Bung (*c.* 2740 m): 1— [in alcohol] (4 June).

The Greywinged Blackbird was occasionally heard and/or seen in eastern Nepal in forests during February and June between *c.* 1060 and 2740 m.

The example under report was a fledgling that could fly only short distances. It was abandoned by its mother on our approach.

Turdus ruficollis atrogularis Jarocki: Blackthroated Thrush

Khumbu: Thami Valley: Thami: 1 ♂ (18 March).

Measurements: 1 ♂: Wing 133, tail 92, bill 33.

Colours of bare parts: Iris dark brown, bill black with yellow on base, legs and feet dark horny, claws black.

The Blackthroated Thrush was seen in Khumbu in flocks of about a dozen birds chiefly on juniper trees in Thami, Bhote Kosi and Dudh Kosi valleys from *c.* 3960 to 4400 m altitude in March and early April.

The testes of my specimen were only slightly enlarged.

Subfamily Timaliinae

***Garrulax albogularis** (Gould): Whitethroated Laughing Thrush

This Laughing Thrush was observed only once in eastern Nepal in a small flock in the forest below Serete, Likhu Valley, Okhaldhunga district, at about 2440 m on 5 February.

Garrulax lineatus setafer (Hodgson): Nepal Streaked Laughing Thrush

Khumbu: Dudh Kosi Valley: below Khumjung: 1 ♂, 1 ♀ (9 April). Solu: Dudh Kosi Valley: Phakding: 1 ♀ (29 May).

Measurements :

	Wing	Tail	Bill
1 ♂ :	78	93+	19
2 ♀ :	75, 75·5	86+, 92	18·5, 19

Colours of bare parts : Iris brown to reddish brown, bill pale horny to horny with dusky on base or on culmen, legs and feet horny brown, claws horny to brownish horny, pads fleshy.

Only a few pairs of the Streaked Laughing Thrush were seen in Solu and Khumbu during April-May at altitudes ranging from about 2800 to 3810 m. It did not appear to be a shy bird at all, and on 29 May at Phakding a pair was seen feeding hardly two metres away from a man who was noisily repairing his bamboo shutters.

The gonads of the April specimens were fairly well developed, and that of the May one was fully developed.

***Garrulax? subunicolor** (Blyth): Plaincoloured Laughing Thrush

On Sangasoti Danda (=Ridge), Chautara district, below Chyaubas at about 2130 m, a small flock of about six birds that appeared to be this laughing thrush was seen on 29 January late in the afternoon.

Garrulax affinis bethelae Rand & Fleming: Eastern Blackfaced Laughing Thrush

Khumbu : Dudh Kosi Valley : Base Camp : 1 ♂, 1 ♀ (3 March) ; Bhote Kosi Valley : Tarangan : 2 ♀ (16 March) ; Thami Valley : Thami : 1 ♀ (17 March). Solu : Dudh Kosi Valley : Phakding : 1 ♂ (29 May).

Measurements :

	Wing	Tail	Bill
2 ♂ :	108, 109	125+, 128	24, —
4 ♀ :	103, 104, 107, 113	125, 126, — (2)	— (4)

Colours of bare parts : Iris brown, bill black, legs and feet fleshy or light brown, claws horny.

The Blackfaced Laughing Thrush was commonly found in Solu and Khumbu in flocks of 4-8 birds or in pairs between *c.* 3000 and 4500 m during February-May. It was very confiding and noisy, and occurred in bushes.

The ovaries of the birds collected on 16 and 17 March had just commenced development, but the testes of the one taken on 29 May were fully developed.

The male taken on 29 May was worn. One of the females taken on 16 March had all its rectrices except the pair next to the central in moult. The moulting feathers were all in about equal stage of development. They were probably growing after their accidental loss.

These eastern Nepal birds are somewhat intermediate between those of the Nepal Valley and Sikkim, but are closer to the latter. Five of my specimens (2♂, 3♀), show, as reported by Rand & Fleming

(1957, p. 133) for their eastern Nepal birds, 'a tendency toward paler edgings of the breast feathers, though otherwise most like *bethelae*'. While none of my specimens is close to nominate *affinis*, one (♀) cannot be separated from *bethelae* of Sikkim.

Garrulax erythrocephalus (Vigors): Redheaded Laughing Thrush

Okhaldhunga District: Pankhoma: 1— [in alcohol] (2 June).

In eastern Nepal, the Redheaded Laughing Thrush was seen first on the crest of the ridge separating Solu Khola from Dudh Kosi at Taksindhu (*c*. 3050 m) on 7 February. Later, in the early hours of the cloudy morning of 2 June it was found, just east of Pankhoma, that a Redheaded Laughing Thrush, obviously one of the parents, was tending two fledglings. On my approach, the parent bird and one of the fledglings flew down the slope, leaving the other fledgling for me. The parent bird was undoubtedly of this species, and from the point of view of distribution, should belong to group D of Rand & Fleming (1957, p. 134).

***Minla ignotincta** Hodgson: Redtailed Minla

The Redtailed Minla was sighted only once on Sangasoti Danda, below Chyaubas, Chautara district, at about 1800 m in a flock of about a dozen birds on 29 January.

Yuhina occipitalis occipitalis Hodgson: Rufousvented Yuhina

Khumbu: Bhote Kosi Valley: Paré (*c*. 4000 m): 1 ♂, 1 ♀ (1 April).

Measurements:

	Wing	Tail	Bill
1 ♂:	65	51	15
1 ♀:	63	50	—

Colours of bare parts: Iris dark brown, bill reddish brown, legs and feet dull brownish orange, claws horny.

Only a pair of the Rufousvented Yuhina was encountered by us, that is, the pair collected from a mixed feeding party above Paré.

The gonads of both the specimens were enlarged.

This bird was inadvertently reported under *Yuhina bakeri* by me earlier (Biswas 1962, p. 222). I am thankful to Mr Michel Desfayes for pointing out this error to me.

Alcippe vinipectus chumbiensis (Kinnear): Eastern Whitebrowed Tit-Babbler

Khumbu: Imja Valley: Yaral: 1 ♀ (3 May).

Measurements: 1 ♀ : Wing 55, tail 48, bill 11.

Colours of bare parts: Iris creamy white; upper mandible dark horny, lower mandible pinkish fleshy with horny tip; legs, feet and claws horny; pads white.

The Eastern Whitebrowed Tit-Babbler was common at certain localities in Khumbu between *c.* 3800 and 4000m during February-May, such as the Base Camp in the Dudh Kosi Valley, and Thyangboche and Yaral in the Imja Valley. It was confiding in nature, occurring in loose parties of 4-6 birds in scrub, and occasionally on the ground, specially at the edges of melting snow.

The gonad of the specimen had finely granular ova.

***Heterophasia capistrata** (Vigors): Blackheaded Sibia

The Blackheaded Sibia was frequently observed and heard near Chyaubas on Sangasoti Danda at *c.* 2150 m in Chautara district on 29 January, in the Likhu Valley, Ramechhāp district, at *c.* 1740 m on 5 February, and later in the western slope of the Singalila Ridge, Dhankuta district, on 1 and 2 July.

Subfamily Sylviinae

Phylloscopus affinis (Tickell): Tickell's Leaf Warbler

Khumbu: Imja Valley: Dingboche: 4 ♂ (18, 19, 21 April), Pangboche: 1 ♀ (29 April).

Measurements:

	Wing	Tail	Bill
4 ♂:	56, 58, 61, 62	42, 46, 47, 48	11·5, 12, — (2)
1 ♀:	62	47	12

Colours of bare parts: Iris dark brown, upper mandible dark horny, lower mandible yellow, legs horny, feet and claws dark horny.

The Tickell's Leaf Warbler was first observed in Khumbu near Paré during 26-30 March in very small numbers. Later, during mid-April-May it was not so uncommon in the Base Camp area and in the Imja Valley between *c.* 4300 and 4600 m. It usually occurred singly in scrub.

One of my male specimens (19 April) had but slightly enlarged gonads, but all the other specimens, males and females, had them fairly well developed.

Phylloscopus pulcher pulcher Blyth: Eastern Orangebarred Leaf Warbler

Khumbu: Bhote Kosi Valley: Paré (*c.* 4000 m): 2 ♂ (1 April); Imja Valley: Yaral: 1 ♀ (2 May). Dhankuta district: Chainpur: 1— [in alcohol] (19 June).

Measurements:

	Wing	Tail	Bill
2 ♂:	61, 62	42, 44	12, 12·5
1 ♀:	55	39	12
1—:	—	40	12

Colours of bare parts: Iris dark brown; upper mandible dark horny or black, lower mandible horny or brown with yellow on base and black anterior half; legs, feet and claws brown or horny; pads white, pale yellow or chrome yellow.

This leaf warbler was not uncommon in Khumbu during April-May, and in Chainpur area in mid-June. It occurred in pairs in bushes and trees.

While the testes of one of the males taken on 1 April was somewhat enlarged, those of another male collected on the same day were fully developed. The female (2 May) appeared to have already laid.

Phylloscopus proregulus chloronotus (G. R. Gray): Nepal Leaf Warbler

Khumbu: Dudh Kosi Valley: below Khumjung: 1— (9 April); Imja Valley: Yaral: 1 ♂ (3 May).

Measurements:

	Wing	Tail	Bill
1 ♂:	54	38	—
1—:	51	36	11

Colours of bare parts: Iris dark brown; upper mandible black, lower mandible yellow on basal half but horny anteriorly; legs, feet and claws horny; pads pale yellow.

The Nepal Leaf Warbler was seen only rarely in Khumbu. It occurred in pairs on trees during April-May.

The male specimen had fully developed testes.

Phylloscopus trochiloides trochiloides (Sundevall): Dull Green Leaf Warbler

Khumbu: Imja Valley: Yaral: 2 ♂ (2, 3 May).

Measurements: 2 ♂: Wing 62·5, 63; tail 52, 52·5; bill 12, —.

Colours of bare parts: Iris dark brown; upper mandible black, lower mandible yellowish fleshy with horny tip; legs, feet and claws horny; pads pale yellow.

This leaf warbler did not appear to be common in Khumbu. During May it was found in pairs on trees.

The gonads of both the specimens were fully developed.

Phylloscopus reguloides reguloides (Blyth): Blyth's Leaf Warbler

Solu: Dudh Kosi Valley: Phakding: 1 ♂ (29 May).

Measurements: 1 ♂: Wing 59, tail 45, bill —.

Colours of bare parts: Iris dark brown, bill horny with yellow on edges and gape, legs and feet greenish grey, claws pale horny.

This leaf warbler was noted only once in eastern Nepal, when the specimen was collected. It occurred in a mixed feeding party on a tree.

The testes of the bird were fully enlarged.

Subfamily Muscicapinae

Ficedula strophiata strophiata (Hodgson): Orangegorgetted Flycatcher

Khumbu: Dudh Kosi Valley: Base Camp: 1 ♂ (11 April).

Measurements: 1 ♂: Wing 76·5, tail 60, bill 13.

Colours of bare parts: Iris dark brown, bill black, legs and feet horny, claws dark horny.

The Orangegorgetted Flycatcher was seen during the first half of April in the vicinity of the Base Camp. It was found singly on scrub, and in all only a few birds were sighted.

The testes of the specimen were fairly well developed.

***Niltava sundara** Hodgson : Rufousbellied Niltava

This niltava was found only once in the Likhu Valley, Ramechhāp district, on 5 February at about 1830 m.

Culicicapa ceylonensis pallidior Ticehurst: Himalayan Greyheaded Flycatcher

Okhaldhunga district : Hongu Valley : Bung : 1— [in alcohol] (4 June).

Measurements : 1— Wing 57, tail 48·5, bill 12.

Colours of bare parts : Iris dark brown ; upper mandible dark horny, lower mandible fleshy with horny tip ; legs, feet and claws fleshy brown.

Only a few individuals of the Greyheaded Flycatcher were seen in eastern Nepal. In the forest above Bung a single example was found in a mixed feeding party in the morning, and it was collected. Later in the day in the same area, two birds were seen carrying food presumably into nests placed high up (about 5 m, and not visible, from the ground) on tree-trunks thickly covered with epiphytes.

***Rhipidura hypoxantha** Blyth : Yellowbellied Fantail Flycatcher

This flycatcher was first seen in mixed feeding parties on trees near Those, Khimti Valley, Ramechhāp district, in early February. During March-April it was quite common in Khumbu between *c*. 3610 and 3960 m in the Dudh Kosi Valley, especially so in the Base Camp area late in the mornings when sunlight flooded the area.

Family Paridae

Parus ater aemodius Hodgson : Himalayan Coal Tit

Khumbu : Dudh Kosi Valley : Base Camp : 1 ♀ (3 March) ; Thami Valley : Thami : 1— [in alcohol] (18 March) ; Bhote Kosi Valley : Paré : 1—(2 April).

Measurements :

	Wing	Tail	Bill
1 ♀ :	59	42	10·5
2— :	56, 60	41, 44	11, —

Colours of bare parts : Iris dark brown ; bill black ; legs, feet and claws dark slate grey.

The Himalayan Coal Tit was quite common in the Base Camp area from February to May. It was also found in the Bhote Kosi and Thami Valleys at about 3800-4400 m during March and April.

The ovary of the female specimen (3 March) was not enlarged.

***Parus major** Linnaeus : Grey Tit

We saw the Grey Tit only once, on the bank of the Charnawati Khola, Ramechhāp district, on 31 January at about 1000 m altitude.

***Parus monticola** Vigors : Greenbacked Tit

This tit was observed only once in Khumbu, below Thyangboche at about 3960 m in the Imja Valley on 25 February.

Parus rufonuchalis beavani (Jerdon): Sikkim Black Tit

Khumbu : Bhote Kosi Valley : Paré : 1— [in alcohol] (27 March) ; Imja Valley : Yaral : 1 ♂, 1 ♀ (30 April, 1 May).

Measurements :

	Wing	Tail	Bill
1 ♂ :	70	49	11
1 ♀ :	67	48	11
1—:	65	47	10·5

Colours of bare parts : Iris dark brown, bill black, legs and feet bluish slaty, claws black with bluish slaty on base.

In Khumbu the Sikkim Black Tit was found in the Dudh Kosi, Bhote Kosi and Imja Valleys between *c.* 3655 and 4200 m during March-May.

The Yaral examples (30 April, 1 May) had fully developed gonads.

These Khumbu specimens are similar to Sikkim birds both in coloration and in size.

Martens (1971b) has shown that the blackbellied *P. rufonuchalis* and the rufousbellied *P. rubidiventris* are sympatric in west-central Nepal during the summer when they do not occur in mixed pairs, and that they have different call notes. They should, therefore, be treated as two distinct species (*contra* Vaurie 1950, pp. 41-44 ; 1957, pp. 18-19).

Parus dichrous dichrous Hodgson : Brown Crested Tit

Khumbu : Bhote Kosi Valley : Thammu : 1 ♂ (2 April).

Measurements : 1 ♂ : Wing 74, tail 51, bill —.

Colours of bare parts : Iris reddish orange, bill black, legs and feet bluish slaty, claws horny.

This tit was found in small numbers between *c.* 3650 and 4150 m in Khumbu during February-May. It occurred in pairs in mixed feeding parties.

The testes of the specimen were only slightly enlarged.

This specimen formed the basis of Biswas's (1955) description of *Parus dichrous izzardi*. However, Snow (in Vaurie 1957, pp. 39-40) has shown that *izzardi* is a synonym of the nominate *dichrous*.

***Aegithalos concinnus** (Gould): Redheaded Tit

Several examples of the Redheaded Tit were spotted once in a mixed feeding party near Serete (*c.* 2530 m), Likhu Valley, Ramechhāp district, on 5 February.

***Aegithalos iouschistos** (Hodgson): Rufousfronted Tit

A small flock of about six examples of the Rufousfronted Tit was sighted only once for a few minutes on the scrub below Lamjura Bhanjang at about 2745 m in the Likhu Valley, Ramechhāp district, on 6 February.

Family Certhiidae

Certhia familiaris mandellii Brooks: Mandelli's Tree Creeper

Khumbu: Dudh Kosi Valley: Base Camp: 1 ♀, 1—(3 March, 11 April); Bhote Kosi Valley: Paré: 1—[in alcohol] (1 April).

Measurements:

	Wing	Tail	Bill
1 ♀:	63	48	15
2—:	61, 63	— (2)	14·5, 15

Colours of bare parts: Iris dark brown; upper mandible very dark horny, lower mandible pinkish white (once with dusky tip); legs, feet and claws horny to dark horny; pads white.

This tree creeper was observed only on a few occasions in Khumbu—once below Thyangboche, Imja Valley, on 25 February, three or four times in the Base Camp area between March and May, and once above Paré on 1 April, all between the altitudes of *c.* 3800 and 4000 m.

The ovary of the female specimen (11 April) was enlarged.

Family Nectariniidae

***Aethopyga gouldiae** (Vigors): Mrs Gould's Sunbird

Mrs Gould's Sunbird appeared uncommon in eastern Nepal, where it was seen in Khumbu four times in the Bhote Kosi Valley at about 3655 m during February-May, once in Solu in the Dudh Kosi Valley at *c.* 3050 m in June, and twice in the Hongu Valley at about 3350 and 3655 m in June.

***Aethopyga ignicauda** (Hodgson): Firetailed Sunbird

The Firetailed Sunbird was occasionally seen in Khumbu at *c.* 3050-3655 m between February and May in Bhote Kosi and Dudh Kosi Valleys.

Family Emberizidae

***Melophus lathami** (J. E. Gray): Crested Bunting

The Crested Bunting was seen only once in eastern Nepal, in the Bhota Kosi Valley, Ramechhāp district, at *c.* 1370 m on 1 February.

Family Fringillidae

Leucosticte nemoricola nemoricola (Hodgson): Hodgson's Mountain Finch

Khumbu: Bhote Kosi Valley: Marlung: 1 ♀ (10 March); Thami Valley: Gnachu: 1 ♂, 3 ♀ (23 March); Lobujya Valley: Phalong Karpo, between Phalong Karpo and Thugla: 2 ♂ (23, 24 April); Imja Valley: Yaral; 1 ♀ (1 May).

Measurements:

	Wing	Tail	Bill
3 ♂:	97, 98, 100	66, 68, 69	13, 14 (2)
5 ♀:	93, 95 (2), 97, 97·5	64, 66 (3), 67	13·5, 14 (3), 14·5

Colours of bare parts: Iris brown, bill brown with yellow on base and gape, legs and feet horny, claws dark horny, pads yellow.

This mountain finch was first seen near Lamjura Bhanjang at about 3650 m in Likhu Valley, Okhaldhunga district, on 6 February in a flock of about 20 birds. Later, it was occasionally seen in Khumbu in flocks of various sizes, e.g. about 10 at Marlung, 50 or more at Gnachu, 12-20 in Phalong Karpo-Thugla area, 10-12 at Yaral.

The gonads of the March birds were rudimentary, but those of April and May were somewhat enlarged.

The Gnachu female specimens (23 March) are very worn on the head. Thus, one of them is so worn that the streaks on the head are obliterated, presenting a uniform brown coloration from forehead to crown, with traces of new feathers on the lores; the second specimen is similar to the last one, but its lores consist of all new feathers; while in the third specimen moult has further advanced, so that it has all new feathers on the lores and forehead. The Yaral female (1 May) is slightly worn, but the rest of the specimens are in fresh plumage.

The male from Phalong Karpo has abnormal claws on its hind toes: they are much longer than the normal ones.

Leucosticte brandti audreyana Stresemann: Sikkim Mountain Finch

Khumbu: Lobujya Valley: Thugla, Phalong Karpo: 1 ♀, 1— [in alcohol] (24 February, 26 April).

Measurements:

	Wing	Tail	Bill
1 ♀:	107+	73	13·5
1—:	110	72	13

Colours of bare parts: Iris dark brown; bill dark horny with yellow on base; legs, feet and claws black.

The Sikkim Mountain Finch was found only in the swampy area between Pheriche and Thugla (*c.* 4300-4700 m) during February and May, occurring in flocks of about 20-50 birds.

The ovary of the female specimen (26 April) had just commenced swelling.

Carpodacus rhodochrous (Vigors): Pinkbrowed Rosefinch

Khumbu : Imja Valley : Yaral : 1 ♂ (4 May).

Measurements : 1 ♂ : Wing 72, tail 58, bill 11·5.

Colours of bare parts : Iris reddish brown, bill pale horny with paler lower mandible, legs and feet brownish fleshy, claws horny.

The Pinkbrowed Rosefinch was found in Khumbu early in May in the Imja Valley at about 3900 m. It occurred in small parties of about four birds.

The testes of the specimen were not enlarged.

Carpodacus pulcherrimus pulcherrimus (Moore): Beautiful Rosefinch

Khumbu : Bhote Kosi Valley : Thangmoche (*c.* 4100 m ; 27°50′N, 86°39′E) : 1 ♂, 1 ♀ (8 March) ; Thami Valley : Thami : 2 ♂, 2 ♀ (18 March); Dudh Kosi Valley : below Khumjung : 1 ♂ (9 April) ; Imja Valley : Pangboche : 2 ♀ (18 April), Dingboche : 3 ♂, 1—[in alcohol] (18-21 April) Yaral : 2 ♂ [1 in alcohol] (1 May).

Measurements :

	Wing	Tail	Bill
9♂ :	76(3), 77(2), 78(3), 79	60, 61, 62(3), 62·5, 63·5, 64	12(3), 12·5(4), 13(2)
5 ♀ :	72·5, 74·5, 75(2), 77	60, 61, 62, 63, 64	12(3), 12·5(2)
1—:	75	62	12

Colours of bare parts: Iris brown to dark brown ; bill, legs and feet horny, sometimes lower mandible or legs paler ; claws black.

In Khumbu the Beautiful Rosefinch was a common bird between *c.* 3800 and 4600 m during March-May. It occurred in juniper bushes, sometimes several pairs sharing the same bush.

Four male and two female birds (18, 19 April, 1 May) had slightly swollen gonads.

Rand & Fleming (1957, p. 206) cast doubt on the validity of *waltoni* Sharpe from south-eastern Tibet on the basis of the wing measurements of their Nepal birds. The chief difference between *pulcherrimus* and *waltoni* is not in size, but, as Kinnear (1944, p. 352) has already stated, in their coloration. From that point of view, *waltoni* should be reckoned as a valid subspecies (see also Vaurie, 1959, p. 633).

One of the male specimens (Dingboche, 18 April) is in female plumage. It had minute testes, while the others taken on the same day had them slightly enlarged. In size, however, it is no smaller than the other males.

Carpodacus thura thura Bonaparte & Schlegel: Sikkim Whitebrowed Rosefinch

Khumbu : Imja Valley : Yaral : 1 ♂, 1 ♀ (3, 4 May).

Measurements :

	Wing	Tail	Bill
1 ♂ :	83	73	14
1 ♀ :	81·5	72	13

Colours of bare parts: Iris dark brown, bill horny, legs and feet brownish horny, claws black.

A few small loose parties of the Sikkim Whitebrowed Rosefinch were observed in the Yaral area of the Imja Valley early in May.

The gonads of both the specimens were slightly enlarged.

Both the specimens have slightly worn rectrices.

Carpodacus puniceus puniceus (Blyth): Nepal Redbreasted Rosefinch

Khumbu : Ngojumba Valley : Chugima : 1 ♀ (14 May).

Measurements : 1 ♀ : Wing 108, tail 77, bill from skull 18, from anterior edge of nostril 12·5.

Colours of bare parts : Iris dark brown ; bill horny but lower mandible paler ; legs, feet and claws black.

Three pairs of this rosefinch forming a feeding party were found in the Chugima area on 14 May.

The ovary of my specimen was somewhat enlarged.

The plumage is worn to some extent, and there is no yellow on the breast.

Pyrrhula erythrocephala Vigors : Redheaded Bullfinch

Khumbu : Bhote Kosi Valley : Hunko : 1 ♂ (17 March), Paré : 1 ♂, 1 ♀ (1 April) ; Dudh Kosi Valley : Base Camp : 1 ♂, 1 ♀ (5 April) ; Imja Valley ; Yaral : 1 ♂, 1 ♀ (1 May).

Measurements :

	Wing	Tail	Bill
4 ♂ :	79·5, 80(2), 81	64(2), 67, 68	9·5, 10 (2), —
3 ♀ :	78·5, 79, —	63, 64, —	9·5, 10 (2)

Colours of bare parts : Iris dark brown; bill black; legs pale horny; feet horny, claws dark horny.

In Khumbu the Redheaded Bullfinch was not uncommon between *c.* 3800 and 4100 m during March-May. It occurred in small parties of two or three pairs, generally in clumps of ringal bamboo, and sometimes on rhododendrons also.

The gonads of the Hunko specimen (17 March) were not enlarged, unlike in all the others (1 April-1 May) in which they were somewhat enlarged.

Mycerobas carnipes carnipes (Hodgson): Whitewinged Grosbeak

Khumbu : Dudh Kosi Valley : Tesinga : 1 ♂, 1 ♀ (6 March); Base Camp : 1 ♀ (8 April) ; Imja Valley: Pangboche : 1 ♂ (18 April).

Measurements:

	Wing	Tail	Bill	Width of lower mandible at gape
2♂:	116, 118	94, 98	23·5, 24	15·3, 16·5
2♀:	108, 121	89, 97	24, —	17·3, —

Colours of bare parts: Iris brown; bill horny, paler on base and gape; legs, feet and claws horny.

This grosbeak appeared to be common only in certain areas of Khumbu, specially where there are juniper trees. It is a noisy bird occurring in small parties of four to six individuals.

The gonads of my two April birds were somewhat enlarged.

The male specimen from Pangboche (18 April), with somewhat enlarged testes, is in female plumage except for a few black feathers on the chin, throat and upper breast. It is finishing a complete moult: the right lore is still in moult, the wing and body feathers are very fresh, but the rectrices are slightly worn, indicating that they moulted first.

Like the Sikkim birds (Meinertzhagen 1927, pp. 376-77; Rand & Fleming 1957, p. 208), my Nepal females also vary a great deal in wing size.

Family Ploceidae

***Passer domesticus** (Linnaeus): House Sparrow (altitude up to *c.* 1520 m).

***Passer montanus** (Linnaeus): Tree Sparrow (altitude *c.* 610-2140 m).

Family Sturnidae

***Acridotheres tristis** (Linnaeus). Common Myna (altitude up to *c.* 1830 m).

The above three birds were very common from Kathmandu to extreme eastern Nepal in and about human settlements in the altitudinal zones given against each.

* **Acridotheres fuscus** (Wagler): Jungle Myna

The Jungle Myna was observed once, outside the village Lamadihi (*c.* 1050 m), Chautara district, on 26 January.

Family Dicruridae

***Dicrurus adsimilis** (Bechstein): Black Drongo

The Black Drongo was found from Kathmandu to far eastern Nepal up to about 1830 m.

Dicrurus leucophaeus longicaudatus A. Hay : Indian Grey Drongo

Dhankuta district : Chainpur : 1 ♀ (19 June).

Measurements : 1 ♀ : Wing 127 ; tail, length 131+, depth of fork 39+ ; bill 28.

Colours of bare parts : Iris brick red ; bill, legs, feet and claws black.

The Grey Drongo was a common bird of eastern Nepal between *c.* 915 and 1830 m.

The plumage of the specimen is fairly worn.

Family Corvidae

***Garrulus glandarius** (Linnaeus) : Jay

A small party of the Jay, consisting of about six birds, was seen in a pine forest below Manga Deorali, Ramechhāp district, at about 1830 m on 31 January.

***Cissa erythrorhyncha** (Boddaert) : Redbilled Blue Magpie

Two parties of the Redbilled Blue Magpie, each of four to six birds, were seen in the forest below Milke Bhanjang, Dhankuta district, in the Tamur watershed, at about 1525 m on 28 June.

***Dendrocitta formosae** Swinhoe : Himalayan Tree Pie

The Himalayan Tree Pie was observed once in the Irkhua Valley, Bhojpur district, at about 1220 m on 7 June ; and later (13-28 June), in Dhankuta district, several times in Chainpur area (*c.* 1525 m), and in the forests on both banks of the Tamur river (*c.* 1525 m) between Sango and Taplejung.

***Nucifraga caryocatactes** (Linnaeus) : Nutcracker

The Nutcracker was heard in the forest between Khari and Puyian, Dudh Kosi Valley, Solu, at about 2430 m on 9 February.

Pyrrhocorax pyrrhocorax himalayanus (Gould) : Himalayan Redbilled Chough

Khumbu : Imja Valley : Dingboche : 1 ♂ (20 April).

Measurements : 1 ♂ : Wing 290+, tail 150++, bill, from base 62, from nostril 55, tarsus 54.

Colours of bare parts : Iris dark brown ; bill, legs and feet blood red, claws black.

The Redbilled Chough appeared to be common in Khumbu only at a few places, such as Namche Bazar (in February), Dingboche (in April) and below Phorcha (in May), where it was feeding in the fields in flocks of 10-20 birds. A pair was also seen at Thyangbo on 23-24 March.

The testes of the specimen collected were somewhat enlarged.

The specimen has fairly worn rectrices.

Pyrrhocorax graculus digitatus Hemprich & Ehrenberg: Himalayan Yellowbilled Chough

Khumbu : Bhote Kosi Valley : opposite Marlung across river : 1 ♀ (14 March), Paré : 2 ♂ (29 March).

Measurements :

	Wing	Tail	Bill from base	Bill from nostril	Tarsus
2 ♂ :	260, 276	—(2)	35, 37·5	20, 22	42 (2)
1 ♀ :	257+	155+	34	21	40

Colours of bare parts : Iris dark brown, bill yellow, legs and feet dusky coral red, claws dark horny.

The Yellowbilled Chough was seen in pairs, loose parties or large flocks in various parts of Khumbu. Thus, a pair was sighted on 22 February on the edge of the Khumbu glacier near its head (*c.* 5330 m) ; large flocks in Bhote Kosi and Thami Valleys in March ; and pairs or loose parties in May at Gokyo, Dudh Kosi Valley, where it was very common.

During my stay at Marlung (10-16 March), it was observed that every day at about midday a large flock of this chough flew from north southward high up along the opposite bank of the Bhote Kosi. The same flock was found on 28, 30 March and 1 April during visits to Hunko area to split up into three smaller flocks high above Hunko, one heading westward along the Thami Valley, another across the Bhote Kosi towards the north of Samde, and the third continuing its flight south-southwestward over Paré.

The testes of my male specimens were somewhat enlarged.

The rectrices of the Paré birds (29 March) were fairly worn, and the remiges and rectrices of the other specimen (14 March) slightly worn.

Vaurie's (1954, p. 7) measurements of eastern Himalayan birds are much larger than mine from Khumbu. Other specimens present at the Zoological Survey of India (only from Kashmir—Ladakh, Chitral, etc.) are larger birds, and their measurements fit in with those given by Vaurie. Dr Charles Vaurie, who examined my Khumbu material, informed me (*in litt.*) that only the larger male from Paré ' is fully adult . . . the wing and bill [of this specimen] are . . . a little shorter than in the specimens I had seen from eastern Himalayas '.

***Corvus splendens** Vieillot : House Crow

The House Crow was found from Kathmandu east to the eastern border of Nepal wherever there were human habitations up to an altitude of about 1525 m.

Corvus macrorhynchos intermedius Adams : Himalayan Jungle Crow

Khumbu : Bhote Kosi Valley : Namche Bazar : 1 ♂ (9 April) ; Imja Valley : Dingboche : 2 ♂, 1 ♀ (19, 20 April) ; Lobujya Valley : Phalong Karpo : 1 ♂ (28 April).

Measurements :

	Wing	Tail	Bill from		Bill height at nostril
			skull	post. edge of nostril	
4 ♂ :	337, 343, 347,—	222+, 225(2), 230	60(3), 62	40·5, 41(2), 42	22(2), 23(2)
1 ♀ :	338	227	57	38	20·5

Colours of bare parts : Iris blackish brown ; bill, legs, feet and claws black.

The Himalayan Jungle Crow was found from Chautara district east to extreme eastern Nepal above *c.* 610 m during January-July. In Khumbu, it was found in almost all the valleys and occurred singly or in small parties.

All my specimens had enlarged gonads.

Dr Charles Vaurie, who has examined these specimens, informs me (*in litt.*) that they ' are much more similar to *intermedius* than they are to *tibetosinensis*, even though a couple (especially 28119) [= ♂, Namche Bazar] have the bill slightly larger than normal in *intermedius*. One would expect this sort of thing in eastern Nepal. At any rate, your birds are not glossy enough and are too white at the base of the nape feathers to be *tibetosinensis* '.

ACKNOWLEDGEMENTS

I am thankful to Dr Charles Vaurie of the American Museum of Natural History, New York, for kindly comparing some of my material with his, and to my colleague Dr K. K. Tiwari for his helpful suggestions in the preparation of this manuscript.

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The Fauna of Narcondam Island[1]

Part 1. Birds

HUMAYUN ABDULALI

In the *Journal* for August 1971, I had a note on a fleeting visit to Narcondam Island in the Bay of Bengal, when I could only stay for a few hours. It was evident that a regular collecting trip was necessary over a longer period and with the assistance of the Charles McCann Vertebrate Zoology Field Work Fund (see *J. Bombay nat. Hist. Soc.* **70** : 244) I arranged for Messrs S. A. Hussain, Research Assistant, Bombay Natural History Society, and N. J. George, Assistant, Natural History Section, Prince of Wales Museum, Bombay, to visit the island.

They reached Port Blair on 12 March 1972 and on the 14th left by a police launch via Maya Bunder in North Andamans arriving at Narcondam on 16 March. They stayed till the 14th April and during this time collected 48 birds, some mammals, reptiles, and other zoological material. The present paper deals with the birds. The field notes, unless otherwise specified, are from the notes kept by Messrs Hussain and George. The number of birds noted and/or collected is very small, and hardly half a dozen species, including the hornbill discovered just a hundred years ago, are resident. For the sake of completeness the earlier notes and specimens in the Bombay collection are incorporated. Mr Hussain also assisted me at the Society's rooms while I was working out the collection.

The collection though smaller than anticipated includes the following new records:

Dicrurus leucophaeus leucogenys
Muscicapa parva albicilla
Phylloscopus inornatus inornatus
Phylloscopus tenellipes tenellipes
Zoothera sibirica davisoni

Thirty-three birds collected in the Andaman Islands on the journey to and from Narcondam are not dealt with in this note.

The serial numbers relate to S. Dillon Ripley's A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (1961) with additions made in subsequent literature. The measurements are in millimetres. I am grateful to Dr Ripley and his Research Assistant Mr Gorman M. Bond at the Smithsonian Institution for the identification of some of the specimens, particularly the Phylloscopi.

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[1] Received September 1973.

43 **Ardeola bacchus** (Bonaparte). Chinese Pond Heron

1 ♀ 3 April 1970

Not seen on this trip.

51 **Egretta sacra** (Gmelin). Eastern Reef Heron

1 ♂ 12 April 1972

Frequently seen on rocks, all dark grey.

The tails are slightly smaller than recorded in FAUNA and repeated in INDIAN HANDBOOK (1 : 77).

7 ♂♂ 84-91 av. 87·7 ; 2 ♀♀ 84, 88 ; (IH ♂♀ 93-98)

Accipiter sp.

I had noted a small dark hawk (chasing a kingfisher) which remains unidentified. Osmaston (1905) saw two small hawks resembling *Astur* in flight circling round the top of the mountain.

173 **Haliaeetus leucogaster** (Gmelin). Whitebellied Sea Eagle

Quite frequently seen on island—four at one time.

As on the last occasion this bird was seen being mobbed by hornbills.

345 **Amaurornis phoenicurus insularis** Sharpe. Andaman Whitebreasted Waterhen

1 ♀ 23 April 1970

Only seen in one area.

386 **Numenius phaeopus variegatus** (Scopoli). Whimbrel

1 ♀ 8 April 1972

Frequently seen. Settled in trees along shore. When cataloguing the birds in the Bombay Collection, I said that I was unable to decide if any of the material was *variegatus* and listed all, including birds from the Andaman and Nicobar Islands, under the nominate race. We have since received by exchange a pair of *variegatus* from Japan, and it does appear that some of the specimens, particularly those from the Andaman and Nicobar islands, are of this race, being distinguished by :

(*a*) the streaking/marking on the lower back and the rump *contra* pure white,
(*b*) the heavier and duskier markings on the upperparts,
(*c*) the heavier streaking on the breast, extending further on to the belly and the flanks,
(*d*) the barring on the axillaries being more pronounced and heavier, all the bars meeting at the shaft in the centre.

Two specimens, Nos. 21910 (Andamans) and 23260 (Camorta, Nicobars), agree completely with the Japanese birds. Seven others (1 Pulicat, Madras, 1 Narcondam, 2 Andamans, 2 Car Nicobar, 1 Great Nicobar) do not show all the characters listed above, but appear to be different from specimens from western India. Though I can find no references to seasonal changes of plumage, it may be mentioned that all the western specimens were obtained in August-November while the eastern birds are between March and May. Curiously, the 9 western birds include only one female, while 8 of the 11 eastern are females.

The specimen obtained on Narcondam has a white rump, but shows the other characters of *variegatus*. Provision would perhaps have to be made for an intermediate population showing characters of both races. The two groups show no differences in size but the wing measurements are smaller than those indicated for European birds in HANDBOOK OF BRITISH BIRDS (**4** : 176) :

		Wing	Bill	Tail
11 ♂♂	Indian & Japanese	224-238 av. 232	62-84 av. 76·5	91-97 av. 93·5
	(BR. HAND.	232-250	76-86	87-99)
9 ♀♀	Indian & Japanese	229-247 av. 238	77-90 av. 84·5	89-102 av. 97
	(BR. HAND.	243-265	80-90	—)

401 **Tringa hypoleucos** Linnaeus (Sweden). Common Sandpiper

1 ♀ 8 April 1972

Frequent.

402 **Arenaria interpres interpres** (Linnaeus). Turnstone

Noted by Osmaston (1905).

471 **Sterna anaethetus anaethetus** Scopoli. Brownwinged Tern

On 23 April 1969, a male settled on the boat off Narcondam.

508a **Ducula aenea andamanica** Abdulali. Andaman Green Imperial Pigeon

3 : 1♂* 1♀ 1 o?

Wing 235*, 229, 232 ; bill 24, 25, 27* ; tail 145(3)

No evidence of nesting, but frequently seen in ones and twos.

All three are shiny green above and have shorter tails than the Andaman birds (♂♂ 155-161, ♀♀ 154-162), but a ♂ collected on an earlier trip is darker above and measures wing 239, tail 157. One wonders if the extent of the sheen on the upperparts is just an individual variation, as apparently accepted.

509 **Ducula bicolor** (Scopoli). Pied Imperial Pigeon

2 : 1 ♂ 1 ♀

None were visible near the camp, but a nesting colony was found on a rocky islet, about 70 feet high, off the north coast, which could be waded to at low tide. Small trees grew out of the cracks in the rocks, and one about 12 feet high held 8 nests, all of the usual sketchy type distinctive of the family. When examined, most of the nests held a single chick, of various ages, while others still contained an egg. Some of the nests could be reached by hand by climbing up the hillside. The number of nests was estimated at about a hundred. When disturbed the birds flew directly to the main island and settled on trees. Occasionally, three or four would soar high up and drop downwards together for some distance on closed wings, and then glide away to a perch.

Streptopelia orientalis subsp. Rufous Turtle-Dove

George twice noted a pigeon which he thought was this species but no specimen was obtained.

544 **Chalcophaps indica maxima** Hartert. Emerald Dove

1 ♀ Wing 143 ; bill 18 ; tail 89

A few seen.

The single specimen appears nearest to another female from Camorta, Central Nicobar (Abdulali 1967 : 168).

548 **Psittacula eupatria magnirostris** (Ball). Large Andaman Parakeet

2 ♀♀ Wing 194, 204; bill 37, 38 ; tarsus 19, 19; tail 300, 304.

Common. Three pairs were nesting at varying heights on one *Salmalia insigne* on the shore line near the camp. All the nests contained young and their *chiri . . . . chrr* was often heard outside. A female collected had her mouth full of caterpillars !

[555 **Psittacula longicaudata tytleri** (Hume). Redcheeked Parakeet

Hume (1874, *Stray Feathers* 2 : 184) refers to this species being found on Barren and Narcondam islands, but Osmaston has already suggested that the latter record was in mistake.]

592 **Eudynamys scolopacea dolosa** Ripley. Andaman Koel

5 : 3 ♂♂ 2 ♀♀ 22nd to 28th March 1972.

	Wing	Bill	Tarsus	Tail
♂♂	195, 196, 209	30, 31, 1-1	32, 32, 33	190, 190, 203
♀♀	190, 200	32, 32	35, 35	184, 185

Upon arrival they were very common but they appeared to have diminished in number by mid April. The several calls were prominent early in the morning and in the evening, and sometimes at night. Some of the specimens were very fat on the belly, and there was no evidence of their breeding here. Osmaston (1905) had noted them as common in early October and thought they were cold-weather visitors.

618a **Otus scops modestus** (Walden). Andaman Scops Owl

One caught in a net on 8th April was pulled out and completely destroyed by one of the dogs in the camp. The few breast-feathers and portions of a wing which were recovered agree closely with the single ♀ from South Andamans available for comparison.

The call *whoo-uk*, *whoo-uk* heard at night, high up on the hill, was attributed to this species.

679 **Caprimulgus macrurus** subsp. Jungle Nightjar

A *chaunk chaunk* heard at night high up on the hill suggests this species which has a resident race in the Andamans.

Apus sp.

I had noted (1971) large black swifts soaring out of range. Hussain and George report some large swifts circling round a pair of soaring Sea Eagles much too high to attempt an identification.

Collocalia sp.

Numbers were seen (' thousands at the summit ') but in the absence of specimens it is not possible to add anything to my querying of Osmaston's record of *C. brevirostris innominata* from Narcondam.

739 **Halcyon pileata** (Boddaert). Blackcapped Kingfisher

1 ♀ 30 April 1970 ; 1 ♀ 27 March 1972

Single birds were noted at three places along the shore.

These two females together with a third from Trinkut, Central Nicobars, appear to be brighter in colour than the others available from India.

748 **Merops philippinus philippinus** Linnaeus. Bluetailed Bee-eater

Noted by Osmaston, on passage (?), in early October.

1 ♀

762a **Eurystomus orientalis** subsp. Broadbilled Roller

1 ♀

In my last report (1971), I had referred to a single specimen with a very small bill obtained on Narcondam Island on 29 April 1970 which did not agree with any of the described races. Curiously, this large and conspicuous bird was not seen on the present trip.

773 **Rhyticeros (undulatus) narcondami** (Hume). Narcondam Hornbill

This was easily the most abundant species on the island and breeding was in full swing in March/April, some 73 nests of the standard hornbill type being noted at varying heights above about 6 ft. Hussain kept a daily list of male and female sightings and over the stay of 24 days, 728 male and 149 female sightings were recorded. The disparity in numbers is probably due to the females being mostly imprisoned in their nests, and the males being seen following regular lines of flight to and from the nests.

Two nests examined contained 2 eggs/young each.

Seeds of fruit eaten by both (?) the female and the young were piled up at the bottom of the nest. At least eight different species were prominent but even with the assistance of the Botanical Survey of India, it has only been possible to identify two—*Anamirta cocculus* (L.) W. & A. (Menispermaceae) and *Bassia longifolia* (L.) Macbride (Sapotaceae).

One egg, dirty brownish white in colour, measured 45 × 33.

A hornbill was seen chasing a male Koel and reference has already been made to several together mobbing a fishing eagle.

Two young, a male and a female, taken from the same nest have been brought to Bombay and now live noisily at the Society's premises in Hornbill House.

The species is protected and appears to be thriving on the island. Unless commercialized in some manner, I do not think that it is in danger and it need not have been put on to the I.U.C.N. Red List.

917 **Hirundo rustica gutturalis** Scopoli. Eastern Swallow

1 ♂ 1 ♀ 9 April 1972. Wing 112, 113

Considerable numbers appeared to be present on the island throughout the period and large numbers (' several hundreds ') flew low over the bay during a drizzle on the day after a storm. On my last visit I had noted a large swallow with whitish underparts and a forked tail, which I could not identify.

950 **Lanius cristatus lucionensis** Linnaeus. Philippine Brown Shrike

1 o ? 29 March 1972

A few seen.

This and another ♂ obtained on South Andaman on 20 April 1972 have grey heads and no bars on underparts.

966b **Dicrurus leucophaeus leucogenys** (Walden). Whitecheeked Grey Drongo

1 ♂ 24 March 1972

Others were seen in the same area. When picked up, hair-like feathers were noticed at the nape which are now seen with difficulty. Similar hair can be seen in dark specimens of the same species from Bhutan and the Eastern Ghats.

The subspecific identity has been determined by Mr Bond. This is an interesting record of this race from Indian limits, as one sent from the Andamans by Capt. Wimberley and identified by Hume as *leucogenys* has appeared under *D. l. salangensis* Reichenow in INDIAN HANDBOOK (5 : 122). Mr Bond has drawn attention to the fact that the tail is in moult with the feather sheaths present, the dark tail-feathers being shed during the first winter and being replaced by grey ones, which in the present specimen project beyond the fork in the tail.

1018 **Gracula religiosa andamanensis** (Beavan). Andaman Hill Myna

1 ♀ 23 April 1969 ; 1 ♀ 20 March 1972, ovaries enlarged

Small parties seen from time to time.

The two females (1 collected on an earlier trip) from Narcondam resemble *andamanensis* but are larger (wing 169, 170 *contra* 160-166 av. 162·7 ; tail 80, 89 *contra* 71-82 av. 77·75) and tend towards the Central Nicobar birds.

1407 **Muscicapa latirostris** Raffles. Brown Flycatcher

1 o? 12 April 1972

This is a well-known winter visitor to the Andamans, Car Nicobar, and to Camorta, Central Nicobars.

1412 **Muscicapa parva albicilla** Pallas. Eastern Redbreasted Flycatcher

1 ♂ 22 March 1972

This was identified by Mr Bond and is a new record, not only from Narcondam, but also from the Andaman group. Incidentally while attempting its identification it was noticed that three males of *M. subrubra* in the Bombay Natural History Society collection from Kashmir (2) and Point Calimere, in distinctive plumage, have the second primary shorter than the sixth as required in the Key in the INDIAN HANDBOOK (7 : 139) and not shorter than seventh as stated on page 159 (loc. cit.).

1549 **Phragamaticola aedon aedon** (Pallas). Thickbilled Warbler

1 ♂ 29 March 1972

In Indian literature the nominate race is accepted in the Andamans and Nicobars but Dementiev and others in BIRDS OF THE SOVIET UNION (1968) refer to *rufescens* Stegmann as the subspecies found in this area. With the material available it is not possible to confirm or deny this.

1586 **Phylloscopus fuscatus fuscatus** (Blyth). Siberian Dusky Leaf Warbler

1 ♂ 1 o? 26 and 31 March 1972

1592 **Phylloscopus inornatus inornatus** (Blyth). Siberian Yellow-browed Leaf Warbler

1 ♂ 1 o? 26 and 31 March 1972

This species has not been recorded previously from the Andaman and Nicobar islands.

1612a **Phylloscopus tenellipes tenellipes** Swinhoe. Palelegged Leaf Warbler

3 ♂♂ on 22, 23 and 29 March 1972

Except for a single specimen captured on a boat 10 miles east of Great Nicobar, there is no record of this species either from these islands or anywhere in Indian limits.

1732a **Zoothera sibirica davisoni** (Hume). Siberian Thrush

1 ♂ 6 April 1972

One was collected out of a party of four high up the hill where other birds were conspicuous by their absence. This was identified by Mr Bond. The only traceable record from the Andamans is a female (?) collected by Capt. Hodge at Port Blair and described as a new species *Oreocincla inframarginata* by Blyth *Jour. Asiat. Soc. Bengal* **29** : 106 ; 1860. If further evidence shows that the Siberian Thrushes visiting this area are not of the nominate race, the name *inframarginata* would have priority over *davisoni.*

1762 **Turdus obscurus** Gmelin. Dark Thrush

2 ♂♂ 23 April 1969 and 20 April 1970

I had commented (op. cit.) on the last two trips each yielding a specimen of this thrush. It was not seen on this occasion.

1864 **Anthus cervinus** (Pallas). Redthroated Pipit

1 ♂ 5 April 1972. Wing 85 ; bill 12 ; tail 59

Only one seen on the edge of the forest.

In length, the bill can be matched with that of another from Prome, Burma, but it is much heavier than any of the seven redthroated adults available for comparison.

1874 **Motacilla indica** Gmelin. Forest Wagtail

1 ♀ 29 March 1972. Wing 77 (77-81) ; tail 68 (65-68)

Osmaston had seen it in the first week of October ; the present specimen was one of several seen.

1875/6 **Motacilla flava** subsp.

1 ♂

These birds were common on the rocks on the shore and would visit the drip from the freshwater pipe.

1884 **Motacilla caspica** subsp. Grey Wagtail

4 : 3 ♂♂ 1 ♀ 18, 20(2) and 28 March 1972. Wing 80(2), 82, 83 ; tail 87, 88, 89, 90

Two males are in almost full breeding plumage.

Vaurie (1959, BIRDS OF PAL. FAUNA : 87) accepts C. L. Brehm's *robusta* with tail 80-96 mm *contra* 92-103 in nominate *caspica* (*cinerea*). In an earlier paper, he has noted the nominate race from Andamans. The present specimens suggested the eastern form, but an examination of 26 males from Iraq, Chitral, Garhwal, Simla, Bombay and Kerala, in the Bombay collection, shows a tail range of 76-92 av. 87. Are they all *robusta* ?

1913 **Nectarinia jugularis andamanica** (Hume). Yellowbreasted or Olivebacked Sunbird

5 : 3 ♂♂ 2 ♀♀

The Narcondam birds have slightly larger wings than those from the Andamans, but the series available does not show any noticeable difference in colour.

	Wing	Bill	Tail
5 Andaman ♂♂	52, 53, 54(3)	19, —	33, 34
4 Narcondam ♂♂	56, 56·5, 58, 59	19, 20, 20, 21	34, 36, 36, 37
3 Andaman ♀♀	50, 53, 53	17·5, 19, —	29·5, 31, 31
2 Narcondam ♀♀	52·5, 55	18, 19·5	29, 34
(FAUNA	52-58	18-19	32-38)

The measurements include those of 3 males from Andamans borrowed from the Zoological Survey of India.

Osmaston (1905) said it was the commonest bird on the island and chiefly frequented the shore. An old typically sunbird nest was found about 3 feet from the ground.

As this paper is being published in the Sálim Ali *Festschrift* I take the opportunity of adding a few words. Sálim Ali was perhaps the first man I saw going round the countryside with a pair of Zeiss 8 × 40 slung round his neck. Having been permitted to peep through them, the acquirement of a similar pair became one of my life's ambitions, which I was fortunately able to realize with the help of a Sunday paper puzzle! In the early thirties I spent three long college holidays with him in Hyderabad and Travancore where he was carrying out ornithological surveys. During these expeditions, I got my first real introduction to collecting and field work and, a few years later, we jointly produced the BIRDS OF BOMBAY AND SALSETTE, the precursor of the several popular books which he has since written.

Most ornithological work in India has been carried out by people in the Imperial Services, keenly enthusiastic, but hindered by the fact firstly that they could only undertake the work as a hobby and, secondly, that they had no control over their transfers and movements and so no continuity of work was possible. Workers like E. C. Stuart Baker, Hugh Whistler, and C. B. Ticehurst carried on after retirement, but this work was necessarily of a taxonomic nature.

Over the last 50 years and even perhaps today, there is no living for a wholetime ornithologist in India. Sálim Ali however carried on and succeeded in making his hobby a successful profession enabling him to assist further research in the ornithological field. His position in Indian ornithology is unique, and will no doubt be sustained as such by his many books.

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Adaptations of Andean and Tibetan birds: a brief comparison[1]

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The Andes and Tibet—the Roof of the World—are the most formidable and extensive mountain assemblages of the world. Both constitute temperate or cold plateaux over which rise very high mountains surrounded by tropical or semi-tropical warm habitats at least for a part. Animals which succeeded the colonization of these regions had to adapt not only to altitude, but to its ecological consequences, particularly a harsh climate and a scarce vegetal cover.

Of course conditions differ to a great extent in both areas, above all in consequence of the different latitudes under which they lie. The high Andes from Colombia to Peru are located within the intertropical zone, whereas Tibet has a more northern situation and its northern border is contiguous to cold regions. Nevertheless, as many ecological features are similar, it is worthwhile to compare the evolution and convergent ecological adaptations of the Andean and of the Tibetan avifaunas.

Comparisons can also be made with the high mountains of Africa, though the African montane habitats merely constitute small 'islands' isolated amidst warm tropical lowlands. In spite of their very specialized fauna, they are not similar to the other high mountains in regard to speciation and faunal differentiation. Ethiopia is the only part of Africa where corresponding geographical conditions occur, as there is an extensive highland area, but average altitude is lower and birds have to face less severe ecological factors.

This paper mostly refers to the Northern plateau of Tibet (Chang Tang) and to the high Andes of Ecuador and Peru (the Chilean sector differs widely by its climate and ecological conditions), and mentions only briefly the African mountains. It considers only a few of the adaptations of birds established in the upper zone, above about 4000 m. where open habitats are largely dominant.

In both areas, climate is very harsh. In the Andes, mean temperatures are relatively low, the annual mean temperature averaging 1-2°C in the region of lake Titicaca. There is a wide daily range, sometimes

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[1] Received August 1972.

from −15°C at night to +15°C and more during the day. The northern sector is humid, due to high rainfall, well distributed through a good part of the year. The southern sector is much drier, as rainfall is concentrated during the austral summer and as the dry season is long and very severe; dryness and cold are exaggerated by strong winds. There is no snow under 4000 m, except during brief storms, after which it rapidly melts.

In the part of Tibet considered here, climate is still more severe. Temperatures are very low, and may fall well below freezing during any part of the year (temperatures of −44°C have been recorded). Rains are restricted to a short period during the summer. Thus dryness is an important feature, accentuated by strong and almost permanent winds. Snow may cover the soil for long periods, even in summer. Climatic conditions are definitely more severe than in the Andes, particularly in winter, due to cold and snow.

It is not surprising that such conditions strongly influenced the vegetal cover. Arboreal vegetation is absent from the upper level, except in a very few places. Grassy alpine steppes predominate across flat expanses, valley beds or plateaux, formed of coarse tufts of Gramineae between which grow a small variety of herbaceous plants and sparse bushes. Shrubs and other ligneous plants only grow in sheltered places, close to cliffs or on well exposed slopes. Beyond a certain altitude, around 5000 m, but varying according to local conditions, the landscape is barren and rocky habitats maintain the last vestige of vegetation.

Birdlife reaches the limits of permanent snow. In the Andes, various birds such as *Thinocorus orbignyianus*, *Cinclodes fuscus*, *Geositta cunicularia* and even hummingbirds such as *Patagona gigas* are observed up to 5000 m. In Tibet *Pyrrhocorax graculus*, *Grandala coelicolor* *Prunella collaris* and *Carpodacus puniceus* commonly live at elevations of 5700 m. Practically birdlife ends at the upper limit of vegetation. But birds were recorded at much higher altitudes, particularly in Tibet, where *Anthus novaeseelandiae*, *Phoenicurus ochruros*, *Columba rupestris*, *Corvus corax*, *C. macrorhynchos*, *Upupa epops* and *Prunella collaris* were observed at well over 6000 m, and *Pyrrhocorax graculus* at 8229 m; geese have been reported as flying at a height above that of Mt Everest (8847 m) during migrations (quoted by Vaurie 1972). Apparently they live with perfect ease in spite of the incredible effort needed just to fly.

EVOLUTION AND SPECIATION

It is needless to say that the avifaunas of these two regions differ fundamentally by their origin and that they have no relationship, except a few ubiquitous birds represented in each area by allied species. The

Andean avifauna derives from stocks which emigrated from the surrounding lowlands or from Patagonia from where a series of birds spread northwards. The avifauna of Tibet, and particularly of the part concerned, is chiefly of Palearctic origin, though a few Sino-Himalayan elements penetrated even the Chang Tang (7 species according to Vaurie 1972). In spite of different origin, birdlife shows some astonishing convergences and parallelisms in evolution due to identical factors of the environment to which they had to adapt.

Both avifaunas are greatly impoverished when compared to those of nearby lowlands. Climate acted as an efficient filter and eliminated a large number of potential colonizers, particularly those which are partial to closed habitats. The upper Andes are inhabited by 153 species, aquatic birds excluded (Vuilleumier), and the northern plateau of Tibet by 175, among which only 67 are found on the Chang Tang. Both avifaunas are more diversified than their African counterpart. In Africa only 74 species are met in the montane non-forest zones, which due to its limited surface, have never been active centres of differentiation in contrast to the forests which surround them (Moreau 1966).

In the Andes and in Central Asia, very active adaptative radiation occurred in relation to isolation. Andean 'islands' conform to archipelagos in many ways, in spite of some differences (Vuilleumier 1970). Though adaptative radiation interferes with geographic speciation, which also reaches a very high degree in mountains as a consequence of discontinuity of ranges and variety of habitats, lack of competition due to the limited number of original stocks favoured differentiation of sympatric species occupying various niches. In the Andes this phenomenon affects particularly Furnariidae (*Geositta*, *Upucerthia*, *Cinclodes*, *Asthenes*), Tyrannidae (*Muscisaxicola*) and Fringillidae (*Spinus*, *Sicalis*, *Phrygilus*).

In Tibet, adaptative radiation occurs among Turdidae (*Phoenicurus* is represented by 9 of its 11 species), Fringillidae (*Carpodacus*, with 14 of the 17 species of the Old World; *Rhodopechys*, with 3 of the 4 species of the genus) and Ploceidae (*Montifringilla*, with 6 of the 7 species of the genus, 4 being endemic ; ecological differentiation is particularly visible among Snow Finches, each species being adapted to a well defined habitat). It is worthwhile to note that granivorous birds radiated intensively, probably in relation to the diversity and the large amount of seeds available in these habitats. The Andes and Tibet have been very important evolutionary centres, a fact also attested by the number of characteristic species, endemic or having secondarily spread over larger areas.

In contrast adaptative radiation did not occur in the montane non-forest zones of Africa, even in Ethiopia, probably as a consequence of the limited areas involved.

PARALLEL EVOLUTION

In spite of their completely different origin, the Andean and the Tibetan faunas show striking parallelisms. Homologous species differentiated in the same type of habitat, due to similarities of available ecological niches. In a very few cases, they belong to the same genus. Thus pipits of the genus *Anthus* nest on the high Andean plateaux (*A. correndera*, *A. furcatus*, *A. bogotensis*) and in Tibet (*A. roseatus*), apparently in the same type of habitat. Many raptors, such as representatives of the genera *Buteo* and *Bubo* and grebes (*Podiceps*) are found in both areas, where they occupy the same niches. But in most cases, birds originate from very different stocks and show remarkable convergences. In Tibet, Snowcock *Tetraogallus tibetanus* peculiar to stony habitats, Partridges *Perdix hodgsoniae*, and Sandgrouse *Syrrhaptes tibetanus* peculiar to grassland, occupy somewhat the niche filled in the Andes by various tinamous, and maybe also by Seedsnipes *Thinocorus orbignyianus*. Several Tibetan larks (*Calandrella cinerea*, *C. acutirostris*, *Eremophila alpestris*, *Melanocorypha maxima*) and wheatears (*Oenanthe deserti*) are the ecological equivalents of various Andean Furnariidae, particularly representatives of the genera *Geositta* and *Upucerthia*, many of which show similar morphology, pattern and even behaviour. Many similitudes also exist among seedeaters, well represented in both areas. In the Andes, birds belonging to the genera *Phrygilus*, *Sicalis*, *Spinus* and *Zonotrichia* are well diversified and their populations abundant through most of the habitats, particularly in grasslands which cover extensive surfaces on the altiplano. In Tibet, birds of the genera *Montifringilla*, *Acanthis*, *Leucosticte* and *Carpodacus* occupy the same niches and are just as numerous. Among insectivores, *Phoenicurus* can in some way be considered as the equivalent of various Tyrannidae, such as *Muscisaxicola* and *Ochtoeca*.

It can be admitted that at least at some levels, the Andean and the Tibetan ecosystems have the same structure and that birds of different origins play the same role in the ecology of these two regions. In contrast there are differences, due to geographical and ecological features. Aquatic avifauna is well diversified on the Andean high plateaux in relation to the wealth of lakes and wetlands. A series of ducks (*Anas flavirostris*, *A. puna*, *A. spinicauda*, *A. specularioides*, *Oxyura ferruginea*), grebes (*Podiceps rolland*, *P. occipitalis*), coots (*Fulica americana*, *F. gigantea*), Ardeiformes (*Plegadis ridgwayi*, *Nycticorax nycticorax*) and some waders colonized various aquatic habitats where their populations are often numerous. They have no equivalent on the Tibetan plateaux where the breeding Anseriformes are mostly *Aythya nyroca*, a scarce bird, and *Mergus merganser*, a characteristic bird of the highlands from 4000 to

4700 m, avoiding the lower elevations during the breeding season. Except *Anser indicus*, *Tadorna ferruginea* and a few ducks, the other Anseriformes met on the northern plateau of Tibet are mostly migrants or stragglers.

Among other aquatic birds, grebes and gulls nest in both regions, *Larus serranus* in the Andes and *L. brunnicephalus* in Tibet, where common terns *Sterna hirundo* also nest up to 4800 m, without equivalent in the Andes. Waders, present in both regions, at least as migrants, are more diversified in Tibet where several nest, among which *Charadrius mongolus*, up to 5100 m, the Redshank *Tringa totanus*, *Gallinago solitaria*, up to 4500 m (its Andean counterpart is *G. paraguaiae*), and the Ibisbill *Ibidorhyncha struthersi*, a bird strictly adapted to streams.

Broadly speaking, though the Tibetan avifauna comprises a few birds with no Andean equivalent, aquatic communities seem much less flourishing in Tibet than in the Andes, maybe in relation to lower productivity of the adequate biota and to severe winter conditions, though the latter might be overcome by seasonal movements.

In each area other birds are found with no equivalent in the other for both faunistic and ecological reasons. Thus the Andean hummingbirds (*Oreotrochilus*, *Chalcostigma*, *Patagona*) have no counterparts, no sunbird being adapted to high elevations. In contrast, some Tibetan birds such as the crane *Grus nigricollis* and corvids have no Andean equivalents.

Nevertheless, the avian communities of the two regions show remarkable convergences. When the same niche is available in both areas it is occupied by birds from different origin, but which evolved with some parallelism. Birds exploit the same type of resources, and concentrate at the same trophic levels. Vegetarians are numerous and insectivores are present, though not the dominant group. Most of them are specialized feeders and many are polyphagous. Raptors also are numerous and well diversified, particularly in Tibet, many of them preying on rodents. These mammals play a very important role in the high mountain ecosystems, as converters of vegetal to animal matter, being abundant and much diversified. Many of them are active in daytime, probably as a response to nocturnal coldness. Therefore they can be preyed on by many raptors, such as buzzards, the diet of which is largely made up of these mammals.

It should be stressed that vultures are numerous in Tibet, just as they are in the high mountains of Africa, particularly in Ethiopia, whereas their Andean counterparts are scarcer and less diversified. This could be related to the fact that larger mammals are much more diversified in the Old World than in the Neogea. Therefore large scavengers could not find a suitable niche in the Andean habitats where the only indigenous ungulates are Auchenidae and a few deer.

ECOLOGICAL ADAPTATIONS

In both regions, birds had to overcome many difficulties to colonize the upper zones. The few which succeeded had to adapt to very hostile environments, not only to altitude in itself, but also to its climatic consequences. As a response to low oxygen pressure they developed anatomical and physiological mechanisms, probably the same in all areas of high elevation over the world. Other adaptations are of ecological nature, and probably these are even more important to the birds. Remarkable convergences are found when birds from the Andes and from Tibet are compared.

Birds are not evenly distributed over these bleak regions, but concentrate in the most favourable places. Therefore their distribution is largely discontinuous and their populations split into small units, sometimes separated over great distances by unsuitable habitats (this had a consequence on speciation, definitely favoured by such distribution). As birds had to concentrate within small areas, many became gregarious. In the Andes, many birds show a strong tendency to gregariousness, at least during the non-breeding season. Many passerines, such as Fringillidae, gather during the night in sheltered places, under rocks or in crevices, which provide roosts and better refuges against cold and bad weather. During the breeding season, many concentrate in small areas, where territories are reduced in size, and feeding grounds often shared by several pairs with no agonistic behaviour. Favourable nest-sites are occupied by many birds which gather and build their nests at short distances from one another. This occurs in the few arborescent plants of the altiplano, such as puyas (*Puya raimondii*, Bromeliaceae), and along cliffs as well.

In Tibet, birds show the same tendencies. Barheaded Geese nest in large colonies and even lay their eggs in a very promiscuous manner. Hume's Ground Jay *Pseudopodoces humilis* lives in small parties of 5-15 birds looking collectively for their food on the ground. Rednecked Snow Finches (*Montifringilla ruficollis*) do the same and Adams' Snow Finches (*M. adamsi*) even live in bands numbering up to 100 birds which display well defined social behaviour patterns. A tendency to gregariousness is found in *Grandala coelicolor*, *Acanthis flavirostris* and various representatives of the genus *Carpodacus*. Several of these birds have collective displays, which are also known in Robin Accentors, *Prunella rubiculoides*. As in the Andes, birds concentrate in the most favourable nest-sites where their density can be very high. In a small part of a cliff, nests of *Anser indicus*, *Tadorna ferruginea*, *Bubo bubo*, *Corvus corax*, *Pyrrhocorax pyrrhocorax*, *Columba rupestris*, *Gypaetus barbatus*, *Buteo hemilasius* and *Falco cherrug* were found together, the various birds living quietly side by side, though an active competition exists between birds of very distinct groups.

Rocky habitats are particularly favourable to birds. Open plateaux offer very harsh conditions to animal life, being cold and open to winds.[1] In contrast cliffs and piled boulders provide shelters against wind and snow, and the microclimate is more favourable in their vicinity. Temperatures are higher due to absence of wind and better exposure. Rock warms up quicker and better than earth when exposed to sun, and thus plays the role of a thermal regulator. As food is more abundant and as many nest-sites are available, it is no wonder that birds frequent preferably these habitats, where they nest in large numbers. In the Andes many raptors nest on small cornices along cliffs, such as caracaras (*Phalcobaenus albogularis*) and hawks (*Buteo poecilochrous*), side by side with ibises (*Theristicus branickii*), doves (*Metriopelia melanoptera*), parakeets (*Bolborhynchus aurifrons*), hummingbirds (*Oreotrochilus*) and numerous passerines, such as swallows (*Oreochelidon, Petrochelidon*), and finches (*Sicalis, Spinus*). They build their nests in crevices, sometimes under shelters and even in caves. Adaptation to rock probably opened high mountain habitats to hummingbirds. It has already been mentioned that numerous birds, mostly Fringillidae and Furnariidae, take refuge under rocks and in crevices during the night.

In Tibet too many birds became rupicoline for the same ecological reasons. Among raptors, the Tibetan Saker Falcon *Falco cherrug* nests exclusively in crags[2], in contrast to other races which nest in trees. Similar nest-sites are chosen by *Buteo hemilasius*, *Bubo bubo*, and of course *Falco tinnunculus* and *Gypaetus barbatus*. Barheaded Geese *Anser indicus* nest for a part on crags where they compete with birds of prey, often very successfully. Corvidae, such as *Corvus corax*, *Pyrrhocorax pyrrhocorax* and *P. graculus*, place their nest on crags or in a hole or fissure. Of course Wall Creepers *Tichodroma muraria* find here their optimal habitat up to 5000 m, and other passerines, Rock Sparrows *Petronia petronia* among others, nest in crevices.

Other passerines nest near the ground in hollows, or under stones and boulders. This mode of nidification is particularly adopted by representatives of the genera *Carpodacus* and *Leucosticte*, Roborovsky's Rose Finch *Kozlowia roborovskii*, some Snow Finches such as *Montifringilla adamsi*, accentors and redstarts. Their feeding grounds are located in the same habitat, where vegetal and animal food is more abundant than anywhere else.

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[1] Nevertheless open plains are not void of birds. In Peru steppes are inhabited by some passerines such as *Phrygilus alaudinus*, *Geositta cunicularia* and *Anthus correndera* in addition to various tinamous and seedsnipes (*Thinocorus orbignyianus*). In Tibet, Horned Larks *Eremophila alpestris* breed in the barest and most desolate habitats, usually in the most exposed places (Ali 1946).

[2] Since it uses old nests of ravens etc. and no tree nests are available !—SA.

The vicinity of cliffs also offers a much more favourable microclimate than the nearby areas, allowing the growth of a denser and higher vegetation of shrubs, and occasionally some small trees. Well exposed slopes are covered by dwarf scrub and stunted vegetation, which contrasts with the grassy steppe characteristic of plains and plateaux. This habitat similar to those of the temperate zone attracts a number of birds with strict ecological requirements. In the Andes such places are inhabited by hummingbirds, doves, various passerines such as *Leptasthenura andicola*, *Asthenes d'orbignyi*, *Troglodytes musculus*, *Turdus chiguanco* and *Phrygilus gayi*. In Tibet, their equivalents are *Turdus kessleri*, *Saxicola torquata*, *Phoenicurus frontalis*, *Phylloscopus affinis*, *P. fuscatus*, *Lanius sphenocercus*, *Parus superciliosus*, *Leptopoecile sophiae*, *Acanthis flavirostris*, *Emberiza cia* and *Urocynchramus pylzowi*.

Another way to escape cold and severe weather conditions is to nest in burrows. In habitats with wide daily range of temperature and a great frequency of winds with a great cooling power, detrimental to birds and particularly to their brood, this mode of nidification is highly beneficial. In the Andes, in habitats in which temperatures fluctuate daily from below 0° to 25°C, temperature within a burrow is constantly around 10°C and does not fluctuate more than 2—3°C during the whole nesting season. Birds benefit from a considerable economy of energy, highly advantageous to the young. Besides, the brood is well protected against predators. Certainly a hypogean mode of nidification is known among other birds than those of the upper zones. But it is so widespread in the high Andes and in Tibet (but not in Africa) that it can be considered as a response to the hostile conditions of this habitat.

In the Andes birds nesting underground belong to many groups, ranging from ducks (*Anas flavirostris*), doves (*Metriopelia melanoptera*), and raptors (*Falco sparverius*) to many passerines. Though some use natural cavities or holes excavated by other animals, most dig their own burrows. Andean flicker (*Colaptes rupicola*) dig long tunnels, some 1·50 m deep, in smooth earth or sand of river banks, leading to an incubation chamber, where eggs are laid on bare earth. Others, such as Furnariidae, excavate long tunnels ending in an incubation room where they accumulate vegetal matter, feathers and wool on which the eggs are laid ; some, like the ground tyrants (*Muscisaxicola*) even build a complete nest inside, the brood being thus protected at the same time by the burrow and by a cup-shaped construction.

The same mode of nesting is found among Tibetan birds, a fair proportion of which nest underground. The habit of using burrows of various rodents is a characteristic feature. Several of them live in close association and in good harmony with marmots (*Marmota bobak*) and pikas or mouse-hares (*Ochotona daurica* and allies). Little Owls *Athene noctua* nest in old marmot burrows, thus resembling the Peruvian Burrowing Owl *Speotyto cunicularia* though the latter is able to excavate its own burrow. Ruddy Shelducks always nest in cavities, sometimes among rocks, but often in marmot burrows, the nest being located up to 2 m from the entrance. With its strong incurved bill, Hume's Ground Jay (*Pseudopodoces humilis*) is able to excavate a tunnel from 30 to 180 cm deep, ending in an incubation chamber where moss, grass and wool are stored to form a very snug nest. But often it uses a pika burrow as nest site or shelter. This becomes the normal, if not the exclusive, habit of several Snow Finches (*Montifringilla taczanowskii*, *M. blanfordi*, and to some extent, *M. ruficollis*), which nest in pika burrows, sometimes at 3 m from the entrance, building a big nest of roots, grass and wool.

It should be remembered that underground nidification is unknown in the high mountains of Africa, in spite of the advantages it offers against the aggressive factors of the environment.

Altitudinal migrations

Though well adapted, all birds nesting in high mountains cannot survive the year round in the same habitat. When climatic conditions become too severe, many respond by altitudinal migrations. This phenomenon is known in every mountain range over the world including the temperate regions (Alps, California) where it has been studied more extensively than elsewhere. In the northern Andes, humidity is sufficient at any season to make food available to most categories of consumers which can stay permanently within the same area. In southern Peru, a very severe dry season is unfavourable to many birds, especially insectivores. It is likely that some evacuate the upper zones and descend to lower elevations where food remains available, but these movements should be limited as favourable habitats are not distant and conditions not particularly bad even in the heart of the dry season. It should also not be forgotten that permanent snow is unknown in southern Peru under 5000 m. In contrast, in the Chilean Andes, where winter is much more severe and snow may stay for long periods, altitudinal migrations are well spread among many birds, such as flamingoes, Andean Sheldgeese *Chloephaga melanoptera*, Seedsnipes *Attagis gayi* and Gay's Greyheaded Finches *Phrygilus gayi*. When winter snows set in, most descend to the valleys (Johnson 1965).

Migration is prevalent among Tibetan birds, only a few being sedentary (Vaurie 1972). Over half of the birds are true migrants and most of the others change their habitat or wander over appreciable distances to warm valleys or plains. Some, particularly seed-eaters, are only nomadic and wander on a limited scale to more favourable habitats.

Others, mostly insectivores, are true migrants. Thus *Chaimarrornis leucocephala* descend to the Indian plains. Barheaded geese evacuate their nesting grounds and winter in tropical India, reaching the south-centre of the subcontinent. Even raptors, such as *Bubo bubo*, follow the same movements, because prey is scarce in winter, as many rodents hibernate or display little activity, having stored large amounts of food (pikas, voles of the genus *Alticola*).

Thus Tibetan birds are largely migrants, in contrast to Andean birds, except those from the Chilean sector. The difference is related to the very hostile conditions which prevail in winter, much worse than in the Andes. Some even wander during summer, when weather conditions become too bad. Thus *Grandala coelicolor* gather in bands of up to 300 birds when snow-storms make the land unsuitable to them, and descend to the valleys until the weather improves. Some warblers, such as *Phylloscopus pulcher*, perform the same movements. In view of this behaviour, the breeding success of many seems very low, due to interruption of reproduction.

However some Tibetan birds do not evacuate high altitude in winter. Alpine Accentors *Prunella collaris*, tits *Parus superciliosus*, tit-warblers *Leptopoecile sophiae* and Redbreasted Rose Finches *Carpodacus puniceus* can stay all the year round in the upper zone where they have been observed in winter at an altitude of 5400 m. This represents an incredible resistance to the aggressive factors of the environment.

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Two tropical forests and their birds[1]

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Avifaunal studies were made in two moist dipterocarp tropical rain forests ; Gombak Valley, Selangor, Malaysia (3°18′N × 101°43′E), and Khao Yai National Park, Thailand (14°20′N × 101°30′E), for periods of 90 and 32 days 1958-60 and 1970 respectively. 261 species were recorded, 59 in common, 115 additional in the Gombak Valley and 87 at the National Park. Population density in Khao Yai appeared to be three times that of Gombak. Niche occupancy in the two forests is compared. Feeding flocks of insectivores were formed at both latitudes and their compositions are compared. It is suggested that these flocks lack the complex organization described for similar groups of neotropical species.

Karr (1971) recently compared tropical environments of Panama with forest environments in Illinois. McClure (1965) compared the residencies of birds contemporary to environments in Japan and in Malaysia. These are meaningful studies, but somewhat like comparing day and night ; the differences are greater and more numerous than the similarities. The present study is a comparison of the avifauna of two tropical forests separated by only 11 degrees but in different climates, tropical rain and monsoon ; the Gombak forest at Kuala Lumpur, Malaysia, and the forest of Khao Yai National Park, Thailand.

DESCRIPTION OF AREAS

The Gombak watershed drained by the Gombak river lies at the eastern edge of the state of Selangor, Malaysia, at 3°18′N, 101°43′E and has an altitude of from 600 to 2000 feet. Although thinned of many of the large merchantable trees by lumbering it still presents a closed canopy with a depth of one hundred to two hundred feet. The forest is dominated by Dipterocarpaceae of many genera and species. Trees with a DBH of over 4 inches may be as numerous as two hundred species per acre. Large trees with buttressed boles may include only four or five trees per species per acre. The forest is diverse with a lack of uniformity in species distribution from acre to acre. Fruiting is individualistic by trees (McClure 1966) and so abundant that the bird population moves about the forest following available and preferred foods.

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Wyatt-Smith (1952) classifies this formation as Lowland Dipterocarp forest which extends up to 1000 feet and Hill Dipterocarp forest 1000 to 2500 feet. These two belong to the world formation commonly referred to as tropical lowland evergreen rain forest. The study area at the Gombak entered both levels of forest. Dipterocarpaceae included 50% of the emergent trees of the canopy, from 100 to 150 feet tall. The 70 to 100 feet canopy included not only young dipterocarps but genera of at least ten other families.

This study refers mainly to the valley between 600 and 1000 feet. A logging road extended for two and a half (2½) miles into the forest following contours above the stream. Once each week observations were made along this road from 0700 to 1200 spending two and a half hours going into and similar time coming out of the forest. These tallies covered 90 days and 450 hours over a two-year period. Birds were recorded and counted by both sight and call. This required a training period so that call counts became more accurate as the study progressed.

The Khao Yai study area was in the National Park at 14°20′N, 101° 30′E with an altitude of between 1500 and 2000 feet. This forest was also a dipterocarp rain forest but at the northern edge of the biome and was much less diverse than that further south. It would fall in the second category of Wyatt-Smith, but still be considered as a tropical evergreen lowland forest. The Dipterocarpaceae are the dominant canopy trees but with fewer species than in the Gombak (Smitinand 1968). Where the canopy was closed the forest presented the same open condition at ground level as further south, but with fewer of the shrub-like palms such as bertam palm (*Eugeissona* sp.). The study area had been cut over once and had more forest edge and less closed canopy than the Gombak forest.

The observation route was along a narrow macadam road through the forest, more open and with less overhead canopy than the trail at Gombak. Studies were made here three days each month for a year, totalling 32 days and 128 hours of observations. Each observation began at dawn and lasted until 0900 requiring about three hours to traverse a mile and return. Birds were tallied by sight and by call. As with the Gombak area figs and fruit trees were very important to the distribution and movements of the birds. The forest offered diverse habitats with an abundance of food. The fruiting patterns of the trees has not yet been reported but seemed to be as individualistic as that in the Gombak valley.

In the Gombak valley the rainfall was distributed throughout the year averaging about 50 mm per week with heavier rains in November and December of 100 mm per week. The dry season of January-February brought the rainfall down to 25 mm per week. Temperature averaged 21°C for the year.

In Khao Yai the annual rainfall was 4000 mm, peak rains occurring during the South-West Monsoon from July into October. During other months rainfall was occasional, sometimes lacking for a whole month. Lack of cloud covering during April-May brought the temperature up to 30°C or above, while in December-January it was as low as 18°C.

BIRDS TALLIED IN THE TWO AREAS

There were 174 species recorded along Gombak route totalling 14,631 individuals, and 146 species in the Khao Yai study area totalling 12,596 birds. Some of the bionomics of these data were as follows :

1. *The population ratios :*

The number of species represented by :

		Gombak	*Khao Yai*
Only 1 individual	..	15 (8·6%)	13 (8·9%)
2-10 individuals	..	49 (28·3%)	50 (34·4%)
11-100 individuals	..	73 (42·1%)	48 (33·1%)
101-1000 individuals	..	36 (20·8%)	34 (23·4%)

Apparently there were more species at Gombak in slightly larger flocks than those at Khao Yai.

2. Six hundred miles separated the two forests but there were only 58 species, 20·6% of the total involved in the two areas, that were common to both. These made up 33·6% of the species at Gombak and 40·0% of those at Khao Yai. There were 115 species limited to Gombak as compared with 87 limited to Khao Yai. Either the diversity of niches was greater at Gombak, the birds fitted them more closely than in Khao Yai, or many niches at Khao Yai were vacant.

3. *Population density :* At Gombak there were 450 hours of field observations over a period of three years and at Khao Yai 128 hours over one year. The number of birds tallied per hour was 31·6 and 98·2 respectively. By this method the population appears to have been more than three times as dense at Khao Yai than at Gombak. This may have been an actual difference or it may have resulted from a higher visibility in Khao Yai where the canopy was more open than that along the Gombak route. The number of birds tallied per mile of route through the forest was 66 in Gombak and 321 in Khao Yai, five times as great. To carry this comparison one step further, the average number of birds recorded per day in the field was 164 at Gombak and 321 at Khao Yai. This brings the density down to about double that of the Gombak, but is not valid since the Gombak route is 2½ times that of Khao Yai.

There were 1·2 times as many species recorded in the Gombak valley than at Khao Yai suggesting a more heavily saturated environment, but when the number of birds per species per observation is considered the figures indicate 0·93 birds at Gombak and 2·7 at Khao Yai, again nearly three times as dense a population at Khao Yai.

Over 500 birds of 70 species were weighed with an average weight of 53 grams. Since the same average figures of birds tallied must be used, a calculation of avian bio-mass in the two areas is fruitless ; 8·6 and 20·8 kilograms per observation ; or 3·4 kg and 17·0 kg per mile.

It is estimated that birds can be seen up to about 100 feet in the forest on either side of the trail. Since an acre is a little more than 209 feet on a side, then for each 200 feet (65 m) traversed one acre has been covered. A total of approximately 25 acres is covered for each mile tallied. By this method the counts determined 2·6 and 13·0 birds per acre respectively. The ratio would not change if reduced to hectares. When reducing the averages to the number of birds per species per observation the figures are 1·76 for Gombak and 6·3 for Khao Yai, still a ratio of 3 : 6. By the data and means at hand the population density at Khao Yai appeared to be between three and five times as great as that at Gombak. See Table 1.

4. *Seasonality :* Peak volumes of precipitation were experienced at the Gombak during November and December followed by two months of reduced rain. Peak population density fell in January during this brief dry spell. At Khao Yai there were two definite seasons, wet from May into October and dry from October into April. Peak population density fell in December when the environment was dry. The peaks in both areas were during the period when migrants from the north were present, 15 species in the Gombak and 25 at Khao Yai. At neither locale were these migrants abundant enough to cause this population peak.

NICHE OCCUPATION

Udvardy (1969) summarizes the niche concept as follows : ' By " niche "—which we understand in a figurative rather than a concrete or spatial sense, we mean the role of a particular animal or plant in the community which it fills by virtue of its tolerances and requirements (Hutchinson 1957) and its special combination of structural, functional, and population biological adaptations. Each animal species has its own niche, which is not exactly duplicated by any other related or unrelated form. By and large, however, functional counterparts in related ecosystems are said to fill the same niche ; where such a counterpart is missing, the niche is considered to be empty.'

The niche occupancy in the two forests was different both as to species and their abundance. In Table 2 those species tallied in numbers of approximately one hundred individuals or greater are compared by forest and month. These are arranged as couplets and where related

Table 1

A comparison of populations at Mile 13 Gombak, Selangor, Malaysia, 2·5 linear miles, Aug. 1958—Nov. 1960, and the Elephant Walk Route, one linear mile, at Khao Yai National Park, Thailand, Jan.-Dec. 1970

		MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Number of days of observation	G	9	7	7	8	7	6	6	8	8	8	10	6	90	
	K	3	2	3	3	3	3	3	3	3	2	2	2	32	
Number of bird species recorded by sight or sound	G	122	106	107	96	91	92	82	84	82	88	88	78	173	93
	K	56	50	58	53	52	48	50	44	52	40	50	54	145	51
Total birds tallied	G	2169	1418	1503	1287	1086	979	955	1159	969	1016	1065	1204	14810	
	K	1071	573	1191	1051	817	826	870	1180	776	213	763	938	10269	
Average daily tally	G	241	202	215	161	155	163	159	145	121	127	107	201		164
	K	357	287	397	350	272	275	290	393	259	106	382	489		321
Population density based on peak month	G	100	84	89	67	64	68	66	60	50	53	44	83		68
	K	76	61	85	75	58	58	62	84	55	23	81	100		68
Population density based on average tally	G	147	123	131	98	94	100	97	88	74	77	65	122		100
	K	111	89	124	109	85	86	90	122	81	33	119	146		100
Population density per linear mile	G	96	81	86	64	62	65	64	58	48	50	42	80		66
	K	357	287	397	350	272	275	290	393	259	106	382	469		321
Average number birds per species per mile	G	7	5	6	5	5	4	5	6	5	5	5	6		5
	K	19	11	20	20	16	17	17	27	15	5	15	17		17
Average number birds per species per observation	G	1·9	1·9	2·0	1·6	1·7	1·7	1·9	1·7	1·5	1·4	1·2	2·5		1·8
	K	6·5	5·7	6·8	6·6	5·2	5·7	5·8	8·9	5·0	2·6	7·6	8·6		6·3

TABLE 2-(1)

A COMPARISON OF THE COMMON BIRDS OF THE ELEPHANT WALK AT KHAO YAI NATIONAL PARK, THAILAND, AND MILE 13 OF THE GOMBAK VALLEY, SELANGOR, MALAYSIA

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Number of observations	G	9	7	7	8	7	6	6	8	8	8	10	6	90	
	K	3	2	3	3	3	3	3	3	3	2	2	2	32	
Spilornis cheela	G	1·0	1·2	1·8	1·2	1·2	1·2	1·7	1·0	1·8	1·5	1·9	2·1	95	1·3
,, ,,	K	1·0	1·0	1·0	1·6	1·3	1·0	·3	·3	0	0	0	5·5	33	1·0
Argus argusianus	G	2·0	3·0	2·2	2·6	2·9	6·5	5·6	3·7	1·7	1·5	2·0	1·0	196	3·2
Arborophila charltoni	K	1·6	5·0	5·0	5·0	5·0	5·0	5·0	3·3	5·0	2·5	5·0	3·5	137	4·3
Ducula badia	G						2·5	7·0	5·0	1·7	1·0			49	4·0
,, ,,	K	8·0	7·0	14·0	5·3	8·3	12·0	16·0	7·0	5·0	7·0	14·5	13·0	303	9·5
Macropygia ruficeps	G	1·0	3·0	2·0	1·0	5·5	4·0	3·0	4·5	2·0	0	1·0	2·0	96	4·4
Macropygia unchall	K	7·0	4·0	3·3	2·3	11·0	13·0	11·0	10·0	3·0	1·5	8·5	7·0	220	6·9
Treron curvirostra	G	1·5	6·0	2·0			1·5				5·0			28	2·8
,, ,,	K	61·3	·5	3·3	5·0	6·3	5·3	1·3	56·0	4·3	2·0	6·5	41·0	529	16·5

The species are arranged by couplet comparing the two areas: K = Khao Yai, G = Gombak. Blank lines indicate no equivalent in that niche. Some niches are filled by several species at one latitude and one species at the other. Comparisons are made here among species counted from approximately 100 individuals or above, for either of the areas. Figures are the average number tallied per one day's observations.

TABLE 2-(2)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Loriculus galgula	G	2·5			15·0	3·0			6·0		2·0			40	5·0
Loriculus vernalis	K	·7	1·0	1·6	6·6	·3	11·3	·7	8·0	1·7	1·2	1·3		113	3·3
?	G														
Glaucidium brodiei	K	1·6	5·0	3·6	3·3	5·6	2·0	4·0	1·3	5·6	·5	6·0	3·3	112	3·5
Apus pacificus	G	21·4		104·0										254	31·7
No equivalent	K														
Chaetura gigantea	G	8·0	2·0	3·3		4·0	6·5	3·0	3·6		10·6	3·6	4·5	103	5·1
” ”	K								3·0	3·0	·5			19	2·3
Chaetura leucopygialis	G	11·0	11·1	18·0	13·0	13·4	15·3	21·1	12·2	16·0	8·3	6·6	19·0	1125	13·5
Hemiprocne comata	G	9·0	10·0	8·7	9·5	6·7	10·8	7·8	9·6	7·1	5·0	6·0	7·5	711	8·1
Collocalia esculenta	G	16·0	9·3	4·5	4·5	3·8	6·5	12·4	9·5	7·0	9·7	5·0	20·8	621	9·4
Hemiprocne longipennis	G	6·3	4·1	5·5	3·2	3·4	5·8	5·0	4·4	5·2	4·2	6·3	9·7	368	5·4
No equivalent	K														
Cypsiurus parvus	G		1·0	1·0								8·0		10	3·3
” ”	K	1·0	27·0	26·0	20·0	10·7	10·0	15·3	3·3	13·0	2·0	15·5	28·5	443	13·8
*Eurostopodus temmincki**	G	1·9	1·7	1·8	1·2	1·4	1·6	1·2	1·5	1·6	1·0	1·6	1·8	123	1·6
Eurostopodus macrotis	K		2·5	·7			·7	·3	1·3	·3	2·0	·5	·5	32	1·0

* Recorded about 1000 ft. higher on the mountain. Occurs here but has gone to roost before observations started.

TABLE 2-(3)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Merops viridis	G	4·5	6·2	5·0				6·5	2·7	1·0	1·5	5·4	3·5	171	4·6
No equivalent	K														
Anthracoceros malayanus	S*	3·2	2·6	2·5	1·8	3·0			2·5	1·8	2·0	1·8	2·5	145	2·5
Anthracoceros albirostris	K	10·0	4·0	2·0	3·7	2·0	4·0	11·0	6·0	4·0		14·0	10·5	183	5·7
Buceros rhinoceros	G	3·0	2·0	2·7	2·6	2·1	2·9	1·3	4·4	2·1	2·6	2·5	2·7	161	2·6
Buceros bicornis	K	13·0	1·5	8·7	19·0	7·0	6·0	7·3	4·7	6·6	·5	10·0	18·0	276	8·6
Anorrhinus galeritus	G	3·8	4·0	2·2	4·0	3·8	3·0		3·5	3·2	4·0	1·0	5·7	176	3·4
Rhyticeros undulatus	K	3·0	1·0	5·3	2·6	·7		2·0	5·6	2·6	1·0	9·0	6·0	98	3·0
Rhinoplax vigil	G	1·5	2·0	1·9	2·6	1·0	2·8	2·2	2·4	1·1	2·0	1·5	2·2	129	1·9
No equivalent	K														
Megalaima chrysopogon	G	2·3	2·0	1·9	3·4	2·5	1·5	2·5	1·5	1·7	1·0		1.5	103	2·1
Megalaima incognita	K	15·0	15·5	8·3	10·0	7·0	5·7	2·0	3·3		2·0	15·0	16·5	250	7·8
Hirundo tahitica	G	7·4	3·2	2·1	1·7	2·0	2·4	2·0	3·0	11·0	6·2	6·7	8·2	281	4·8
Hirundo daurica	K											12·0	12·0	47	12·0

* = Subang, a nearby secondary forest lower than Mile 13. Listed here for comparison. Not common at Gombak.

TABLE 2-(4)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Hirundo rustica	G	15·2	22·3	9·6	10·0				2·7	12·2	7·0	9·0	17·0	672	12·7
,, ,,	K		1·5	1·3	2·7			2·7	6·0				3·0	47	2·9
Hemipus hirundinaceus	G	1·6	1·0	1·8	2·0			2·0	2·0	2·0	1·5	2·0		34	1·7
Hemipus picatus	G	2·6		3·3	1·2	3·0	1·3		2·7	1·0	2·5	2·0	1·0	53	2·1
,, ,,	K	1·7	1·0	4·6	8·0	5·7	2·7	4·0	8·0	2·0	7·0	4·0	6·5	145	4·5
Pericrocotus igneus	G	12·5	8·5	7·5	19·3	18·0	10·0	4·0	5·7	5·8	9·7	9·7	9·0	535	9·9
Pericrocotus flammeus	G	9·0	7·0	10·0	8·4	10·0	7·0	1·0	3·0	3·0	3·0	5·0	13·0	187	6·6
,, ,,	K	5·0	5·5	22·0	14·0	10·7	13·3	4·6	6·7	5·3	4·0	7·0	6·5	299	9·3
Dicrurus annectans	G	1·6	2·5		1·0					2·5	2·2	1·0	1·0	35	1·7
Dicrurus hottentottus	K	16·7	7·0	5·0	1·6	4·3	2·7	2·0	6·3	·7	2·5	14·0	61·5	287	10·3
Dicrurus paradiseus	G	6·8	5·4	5·4	8·2	6·6	5·7	5·3	3·0	3·5	4·6	4·3	6·3	472	5·4
,, ,,	K	1·3	·5	6·3	3·3	3·7	6·0	2·3	3·7	8·0	1·0	2·5	4·5	121	3·6
Oriolus xanthonotus	G	4·1	5·2	2·8	2·1	2·7	2·2	1·6	2·4	2·0	2·3	2·7	3·8	150	2·6
Oriolus chinensis	K	·3	2·0	1·0							·5	1·0	·5	12	·9
Alcippe poioicephala	G	18·1	11·2	17·2	13·0	7.1	12·0	7·0	9·0	2·5	10·5	8·5	6·0	635	10·1
No equivalent	K														
No equivalent	G														
Garrulax leucolophus	K		2·5		2·0	·3	1·3	3·7		7·7	4·0		6·0	105	3·4
Macronus gularis	G	3·5	3·0	5·0	2·8	3·5	4·2	3·6	6·0	5·5	2·0	2·8	3.5	191	3·9
,, ,,	K	12·0	16·0	18·0	14·0	10·3	11·0	6·0	7·3	10·3	2·5	20·0	11·0	364	11·5

TABLE 2-(5)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Malacopteron cinereum	G	6·0	3·8	2·7	3·0	2·0	2·5	9·5	7·2	1·0	8·0	3·5		115	4·8
Trichastoma abbotti	K	4·7	10·0	6·0	5·6	5·6	5·6	10·0	3·3	3·7	2·0	3·0	1·5	170	5·0
Yuhina zantholeuca	G	4·7		2·0	5·0		2·0			28·0	10·0	1·0		60	6·6
,, ,,	K	1·3		2·0	8·3	6·3	9·3	6·7	2·7	1·3		1·5		117	4·4
Hypsipetes viridescens	G	2·3	3·8	4·8	2·0	6·3	1·7	1·0	4·0		3·5	2·3	4·5	116	3·5
Criniger phaeocephalus	G	4·0	2·5	2·0	1·7	2·0	1·3		1·0	2·7	9·0	1·0	1·0	52	2·4
Criniger bres	G	3·0	1·3	2·0	3·0	3·0	2·1	1·5	7·0			3·0	3·7	57	2·7
Criniger pallidus	K	3·7	20·5	24·0	29·0	13·0	19·0	21·0	20·3	10·0	8·5	16·5	15·5	545	16·7
Pycnonotus brunneus	G	4·5	5·8	3·0	2·0	3·0	3·0	2·0	3·0	7·3	3·5	2·0	3·2	164	3·6
Pycnonotus simplex	G	2·0	3·3	2·7	2·0	4·7	1·0		2·0			1·5	2·0	54	2·6
Hypsipetes propinquus	K	·7	7·0	14·0	15·0	26·7	15·7	12·0	5·7	12·3	6·5	10·0	10·5	373	11·3
Pycnonotus atriceps	G	1·5	1·0	6·0	4·0	7·1	4·0	11·4	12·3	4·7	2·0	1·0		205	5·7
,, ,,	K	·7	1·5	1·7					4·0					22	2·0
Pycnonotus cyaniventris	G	1·5	5·0	2·0	4·5	1·8	2·0	3·3	4·4	3·0		4·5	1·0	118	3·5
No equivalent	K														
Pycnonotus zeylanicus	G	1·8	2·6	2·0	2·2	2·1	1·3	1·5	1·6	1·8	2·0			96	2·0
No equivalent	K														

TABLE 2-(6)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Pycnonotus finlaysoni	G	2·7	2·5	2·7	2·8	4·4	3·3	4·0	1·6	2·3	1·0	4·5	1·8	173	2·8
,, ,,	K	7·0	6·5	8·0	5·3	1·3	6·7	11·0	4·3	9·3	2·0	4·5	8·5	201	6·2
Pycnonotus melanicterus	G	2·0	1·7	2·2	2·0	4·0	1·0	1·0	1·5					34	2·0
,, ,,	K	5·0	5·7	30·0	28·3	17·0	14·7	22·7	14·3	16·0	7·0	7·0	8·5	515	14·7
Chloropsis cochinchinensis	G	16·3	11·7	9·6	7·1	6·0	5·0	9·4	6·2	4·0	9·3	11·0	13·5	720	9·3
,, ,,	K	4·0		·7	3·3	11·0	8·3	6·3	4·7	9·3	2·5	3·5	2·0	159	5·0
Chloropsis cyanopogon	G	5·2	2·0	2·0	4·3	1·5	4·0	1·0	3·0	3·2	5·0	4·3	2·0	143	3·5
Chloropsis sonnerati	G	1·5	1·5	2·0	1·7	3·2	1·0	1·7	1·7	5·5	2·0	3·5	1·0	59	2·0
No equivalent	K														
Irena puella	G	6·1	5·7	5·8	2·7	3·1	4·8	6·2	2·0	2·0	8·8	5·0	7·2	274	4·8
,, ,,	K	16·7	10·5	88·7	30·0	19·3	14·7	15·0	34·3	14·3	4·0	46·5	33·5	887	27·3
Gerygone fusca	G	1·6	2·0	2·0	2·0	2·4	2·4	1·5	1·5	3·1	2·1	2·5	3·2	129	2·0
No equivalent	K														
Aegithina viridissima	G	7·1	7·6	6·7	4·7	8·6	7·1	11·0	5·0	8·0	6·8	9·2	6·5	673	7·2
No equivalent	K														

TABLE 2-(7)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Orthotomus atrogularis	G	3·3	1·7	3·0	2·3	2·5	3·2	1·0	1·9	3·3	3·6	1·2	3·0	167	2·4
,, ,,	K			·7	3·0	1·3	1·3	2·0			·7	·5		28	1·3
Phylloscopus borealis	G	9·7	3·3	3·5							4·0	9·0	13·0	160	7·6
Phylloscopus spp.	K		·5	3·3	2·0						·5	4·0		26	2·0
Culicicapa ceylonensis	G	4·5	2·5	1·8	2·1	3·7	2·2	4·8	4·2	3·1	2·5	3·0	4·0	223	3·3
,, ,,	K	3·7									1·0	2·5	2·5	23	2·4
Arachnothera longirostris	G	10·8	10·0	7·0	8·4	9·0	9·1	8·7	12·0	7·4	5·4	6·0	10·3	710	8·4
,, ,,	K		·5	·3	1·7	3·0		·3		·3			1·0	20	1·0
Arachnothera chrysogenys	G	4·0	3·7	5·2	3·7	5·6	2·8	3·2	3·1	1·3	2·2	1·2	1·0	198	3·3
No equivalent	K														
Gracula religiosa	S*	4·0	1·2	2·1	1·8	1·4			1·0		1·5	1·0		89	2·0
,, ,,	K	102·3	16·0	9·0	7·0	11·0	12·0	20·0	44·0	6·3	9·0	73·5	40·0	908	29·2
Zosterops palpebrosa	G	8·0			12·5	12·0	6·0		3·0					57	8·1
,, ,,	K	5·3	10·0			1·7	8·0	12·0	60·3	38·7	2·0	2·5	5·0	427	14·5
Lonchura striata	G	6·6	10·5	35·0	6·2	2·3	6·5	2·5	7·4	6·6	9·2	6·0	3·0	451	10·2
,, ,,	K	·7	2·0	·7										8	1·1

* = Subang, a nearby secondary forest lower than Mile 13. Listed here for comparison. Not common at Gombak.

species apparently fill the same niche in each habitat they are compared. This table indicates seasonality as well. The figures given are the average birds tallied per observation without consideration of time involved or distance covered. Some species occurred in both forests. Some niches appeared to be occupied by more than one species in one forest and only one in the other. Some niches appeared to be occupied by one or several species in one forest and to be vacant in the other.

In any concept of niche the observer is at a handicap because of his inability to discern the parameters which delineate the niche from the standpoint of the organism occupying it. Inhibiting factors obvious to the organism may escape the observer. In these two forests the presence or absence of related species may be a function of the inability of the forest to provide what is needed to the birds even though the situation appears similar to the observer.

In both forests there were several conditions related to niche. These appeared to be: 1. Niche present in both and occupied by a species capable of increasing to an abundance (abundance is here interpreted to be in numbers so that 100 or more could be tallied). 2. Niche present and occupied only sparsely by a low level population. 3. Niche present but species capable of occupying it were absent. 4. Niche absent. We are still in the position of setting up such categories arbitrarily without reference to the organisms present or knowledge of their critical needs.

The less abundant species and their counterparts are listed in Table 3. Many of the differences evident here appear to be related to thermal conditions, for some species found at Khao Yai at 1000 to 2000 ft. (*c.* 500 m) are found in Malaya at 4000 to 6000 ft. (*c.* 1500 m).

BIRD WAVES

'Wave' action of the birds was evident in both forests, however it appeared to be much more prevalent among the birds at Gombak than at Khao Yai. The birds of Khao Yai were more independent in their food gathering. Both forests had an abundance of insects, but at Khao Yai there was a year-round supply of fruit in greater quantities than was noted at Gombak. Frugivorous birds go to the feeding trees in flocks and mingle with other species present, but there is not the flock organization evident among the species as in a feeding flock of insectivores. A comparison of the flock dynamics is given in Table 4. Size of flock, number of species involved, etc. was similar for the two areas.

Aanlyses of feeding flocks have been reported by many observers including Moynihan (1962, Panama), McClure (1967, Malaya), Diamond & Terborgh (1967, Peru; 1970, New Guinea), Cody (1971, California) and in each paper the factors reported differ. The flocks discussed have varied from single species granivorous feeders through

TABLE 3

A COMPARATIVE LIST OF THOSE SPECIES WHICH DID NOT DEVELOP NUMERICAL ABUNDANCE, FILLED THE NICHES SPARSELY, OR CONVERSELY, THE HABITATS DID NOT PERMIT GREATER POPULATIONS ; OR THE NICHE WAS UNOCCUPIED

GOMBAK	KHAO YAI	GOMBAK	KHAO YAI
Aviceda leuphotes	*A. leuphotes*	*Cymbirhynchus macrorhynchus*	—
—	*Gallus gallus*	—	*Psarisomus dalhousiae*
Rollus roulroul	—	*Coracina fimbriata*	(*C. melaschista* (*C. polioptera*
Chalcophaps indica	*C. indica*	*Tephrodornis pondiceriana*	*T. pondiceriana*
Phaenicophaeus diardi	*P. tristis*	*Pericrocotus divaricatus*	*P. divaricatus*
P. chlorophus	—	—	*Dicrurus leucophaeus*
P. curvirostris	—	—	*D. remifer*
P. javanicus	—	*Platysmurus leucopterus*	—
P. sumatranus	—	—	*Cissa chinensis*
Cuculus micropterus	—	*Melanochlora sultanea*	*M. sultanea*
Surniculus lugubris	*S. lugubris*	*Sitta frontalis*	*S. frontalis*
—	*Carpococcyx renauldi*	—	*Garrulax monilegerus*
Batrachostoma stellatus	—	—	*Garrulax chinensis*
Harpactes duvaucelii	(*H. erythrocephalus* (*H. oreskios*	*Macronus ptilosus*	—
Lacedo pulchella	*L. pulchella*	*Criniger finschii*	—
Ceyx rufidorsus	—	*Pycnonotus melanoleucos*	—
Ceyx erithacus	—	*Pycnonotus squamatus*	—
Nyctyornis amictus	*N. athertoni*	*Copsychus malabaricus*	*C. malabaricus*
Eurystomus orientalis	*E. orientalis*	*Enicurus ruficapillus*	(*E. leschenaulti* (*E. schistaceus*
Megalaima henrici	—	*Culicicapa ceylonensis*	*C. ceylonensis*
Hemicircus concretus	*H. canente*	*Hypothymis azurea*	*H. azurea*
Meiglyptes tristis) *Meiglyptes tukki*)	*M. jugularis*	*Rhipidura perlata*	—
—	*Picus flavinuchus*	*Terpsiphone paradisi*	*T. paradisi*
Sasia abnormis	—	*Lanius cristatus*	*L. cristatus*
Calyptomena viridis	—		
Eurylaimus ochromalus	*Serilophus lunatus*		

TABLE 4

A COMPARISON OF THE FLOCK DYNAMICS OF BIRD WAVES AT GOMBAK AND KHAO YAI

		Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Total or Ave.
Total flocks	G	36	7	10	21	74
	K	3	6	8	14	31
Total birds in flocks	G	1626	270	265	822	2983
	K	56	177	367	476	1076
Ave. no. species per flock	G	9	7	5	8·5	7·6
	K	10	9	9·7	7·2	9·0
Ave. no. birds per species per flock	G	2·4	3·1	2·1	2·9	2·7
	K	1·9	3·4	4·5	4·8	3·6
Ave. no. birds per flock	G	38	30	21	41	34
	K	19	30	46	34	32

many species of insectivores to many species of frugivorous forms using one tree. Each author has given his own interpretation to his observations.

The primary difference between the flocks of insectivores and those assembling in a fruiting tree is that the insectivore ' waves ' move through the forest (generally in a predictable pattern or territory) and the fruit eaters go to a specific tree. Many of the travelling waves contain fruit eaters which have joined them for varying periods or distances, such as the bulbuls or the barbets. If every species that is seen with such flocks is listed there will be many that occur only once in a series of observations. These may or may not be accidentally with the group. If they are seen on two occasions then the relationship may be more than casual. There were 68 species at Gombak and 43 at Khao Yai that were noted in association with feeding flocks two or more times.

McClure (1967) gives tables attempting to relate the species within these feeding flocks, based upon the numbers of times the birds were seen together. Table 5 duplicates this for the eleven species commonly found in waves at Mile 13 Gombak. In this table the figures are given as percentages of the total birds tallied. For example 75% of the 252 Yellowheaded Green Leafbirds (*Chloropsis cochinchinensis*) were seen in company with 83% of the 242 Minivets (*Pericrocotus flammeus* and *P. igneus*). With a less numerous form, 34% of the leafbirds were associated with 85% of the 27 Chestnutbreasted Malkoha (*P. curvirostris*). These data can be interpreted to indicate interspecific affinities, or simply the physical impossibility for 75 or 85% of the leafbirds to be in the flocks with the malkoha when there was only one tenth as many malkohas present.

TABLE 5.—THE NUMERICAL RELATIONSHIPS AMONG THE BIRDS COMMONLY FOUND IN FEEDING FLOCKS AT GOMBAK MILE 13

Species	1	2	3	4	5	6	7	8	9	10	11
1. *Chloropsis cochinchinensis*	**252**	75	46	43	44	46	36	28	23	34	24
2. *Pericrocotus flammeus* and *igneus*	83	**242**	51	39	46	49	38	23	26	35	18
3. *Alcippe poioicephala*	84	75	**215**	43	76	59	46	39	40	27	15
4. *Dicrurus paradiseus*	74	69	46	**58**	52	41	31	21	15	24	31
5. *Oriolus xanthonotus*	73	73	67	58	**48**	46	29	33	33	25	19
6. *Phylloscopus borealis*	82	72	52	41	43	**141**	43	29	22	35	16
7. *Terpsiphone paradisi*	85	76	61	30	42	54	**33**	33	24	33	30
8. *Irena puella*	78	80	35	28	65	30	17	**46**	17	41	33
9. *Hemipus picatus*	73	56	56	29	47	47	41	32	**34**	20	15
10. *Phoenicophaeus curvirostris*	85	85	37	52	48	48	37	41	33	**27**	18
11. *Aegithina viridissima*	69	74	48	55	28	45	50	17	19	14	**42**

TABLE 6.—THE NUMERICAL RELATIONSHIPS AMONG THE BIRDS COMMONLY FOUND IN FEEDING FLOCKS AT KHAO YAI

Species	1	2	3	4	5	6	7	8	9	10	11	12
1. *Hemipus picatus*	**60**	50	55	32	55	52	35	52	35	29	32	12
2. *Yuhina zantholeuca*	55	**69**	61	69	50	69	51	68	35	32	23	26
3. *Hypsipetes propinquus*	46	54	**52**	56	29	65	71	35	44	25	42	13
4. *Macronus gularis*	29	50	58	**38**	8	45	60	24	21	50	47	29
5. *Irena puella*	65	46	46	5	**54**	42	35	63	37	4	11	7
6. *Chloropsis cochinchinensis*	51	65	80	61	43	**51**	57	61	57	21	27	12
7. *Pycnonotus melanicterus*	28	81	54	42	49	47	**57**	70	54	26	26	3
8. *Pericrocotus flammeus*	73	81	52	31	77	67	64	**48**	50	8	12	0
9. *Zosterops palpebrosa*	51	51	68	32	60	77	64	65	**124**	18	28	6
10. *Culicicapa ceylonensis*	68	53	36	63	21	31	26	10	37	**19**	16	47
11. *Criniger pallidus*	65	55	90	59	34	69	48	34	41	21	**29**	7
12. *Hypothymis azurea*	50	87	50	67	33	25	12	0	12	87	12	**8**

Read Tables 5 and 6 horizontally : i.e. 84% of the *A. poioicephala* (Line 3, Column 1) were seen in association with 46% of the *C. cochinchinensis* (Line 1, Column 3). Bold faced numbers are the total birds tallied and the remainder are percentages of these figures.

Arranging the twelve common participants found in waves in Khao Yai in the same way (Table 6), the same relationships appear to be present.

Four species were common to bird waves in both forests, Yellow-headed Green Leafbird *Chloropsis cochinchinensis*, Barwinged Flycatcher-Shrike *Hemipus picatus*, Fairy Bluebird *Irena puella* and Scarlet Minivet *Pericrocotus flammeus*. In the Gombak 75% of the leafbirds were with 83% of the minivets. In Khao Yai 61% of the leafbirds were with 67% of the minivets, the same relationship. The temptation is to ascribe interspecific affinities or relationships to these observations. A review of both tables simply makes it evident that birds get together to find food. At Khao Yai the numerical abundance of species was in the same order, i.e. 60 *Hemipus picatus* and 51 *C. cochinchinensis* with 51% of the leafbirds in association with 52% of the flycatcher-shrikes. In the Gombak they were 252 leafbirds to 34 flycatcher-shrikes and a ratio of 23% of the leafbirds to 73% of the flycatcher-shrikes. A purely spatial and population density relationship in both cases. Species with similar food habits get together to hunt. To go further in interpretation is treading on shaky ground.

SUMMARY

A comparison of the avifauna of the moist dipterocarp tropical rain forest at its northern edge in Thailand and in the centre of its range in Malaya reveals that there is a large species overlap between the two areas, that the population density in the northern edge of the forest was greater than in that under study in Malaysia, that both of these populations may be the result of edaphic conditions brought on by man disturbance. Niche occupancy in both forests was not the same, there being vacancies in both which were occupied in the other. The insectivores in both environments gathered into feeding flocks that moved through the forest each day. The species composition of these flocks depended upon those species available and lacked the complex flock organization reported from the neotropical forest.

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Geographical distribution of the avian lice (Phthiraptera): a review [1]

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The avian lice are obligate parasites, spending their whole life-history from egg to adult on the body of their host without a free-living stage as in the fleas or intermediate hosts as in some of the endoparasites. It might therefore be thought that they would be independent of external conditions such as climate and other ecological aspects of the host's environment. However, the great diversity of structure found amongst the eggs of the lice laid in comparable situations on the body of the bird, some of the differences apparently being related to the host's environment (Balter, in preparation), suggests that the external environment may affect the louse and its distribution. The kangaroo louse *Heterodoxus spiniger* which has become established on the domestic dog in many parts of the world is found almost entirely between lat. 40°N and 40°S (Thompson 1940) and is perhaps limited by some climatic circumstances. Thus, the louse population may be subject to both a micro- and macro-environment, the latter perhaps sometimes influencing distribution (Table III).

The distribution of the lice of birds is mainly a host one and in many cases a genus of louse will be restricted to an order or family of birds with each species restricted to a host species or a group of related host species. It is interesting however, that some orders of birds are parasitized by species with a wide host and geographical distribution (Table I). Published work on the Phthiraptera has concentrated on the host distribution and since Jardine, 1841 first suggested that ornithologists might use the distribution of the Mallophaga to trace relationships between their hosts (see Hopkins 1951), this aspect of the distribution of the Phthiraptera has been developed by Kellogg, Harrison, Hopkins, Clay, Eichler, Timmermann, Kéler and others. Deductions of host relationships from those of their parasites have been made with enthusiasm not always tempered by judgement. In Clay (1957) an assessment was made of the value of this source of evidence for host relationships and the factors which might influence and modify the original relationships. It was

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shown that, in general, the relationships of the lice do reflect those of their hosts and that anomalous distributions are the exception. In some examples of anomalous distribution a species appears to exhibit a geographical not a host distribution, but until recently discussion on this subject hardly appeared in the literature. Hopkins (1949) and Clay (1949) gave some instances and since then it has been mentioned in various papers ; these together with unpublished examples are reviewed here. Apologies are made to those authors who have written on this subject but whose papers have been overlooked.

TABLE I

PHTHIRAPTERAN SPECIES WITH WIDE HOST AND GEOGRAPHICAL DISTRIBUTIONS

PHTHIRAPTERA	S.	G.		N.	P.	E.	O.	A.
Colpocephalum turbinatum	36	20	(Falconiformes)	+	+	+	+	+
Colpocephalum fregeli	15	3	(Corvidae)	+	+	+	+	+
Ciconiphilus decimfasciatus	22	16	(Ardeidae)	+	+	+	+	+
Cuculiphilus snodgrassi	14	9	(Cuculidae)	+	+	+	+	?
Laemobothrion maximum	32	18	(Falconiformes)	+	+	+	+	+
Eidmanniella pellucida	10	1	(*Phalacrocorax*)	+	+	+	?	+
Holomenopon leucoxanthum	29	12	(Anseriformes)	+	+	+	+	+
Degeeriella regalis	9	4	(Falconiformes)	+	+	+	+	—
Saemundssonia africana Timmermann, *sens. lat.*	11	10	(Vanellinae)	—	—	+	+	+
Columbicola theresae Ansari	5	2	(Columbidae)	—	+	+	+	—

S. species, and G. genera of the host parasitized. N = New World (Nearctic & Neotropical); P. Palearctic ; E. Ethiopian ; O. Oriental; A. Australasian (including New Zealand). ? None recorded, possible hosts present.

Authors and dates of all Phthirapteran species up to 1951 as in Hopkins & Clay 1952.

The Amblyceran examples are taken from the revisionary work of Price *et al.* and the *Columbicola* from Tendeiro, 1952.

Geographical distribution in the Phthiraptera may be due to various causes which for convenience can be considered under the following headings : Absence, Primary and Secondary ; Secondary Infestations ; Geographical Isolation of Host ; Unexplained Distributions. These divisions are not entirely satisfactory as some of the examples could be considered under more than one of the headings and there is always the dual role of host distribution and geographical distribution making much of the evidence difficult to evaluate.

ABSENCE

a. *Primary.* The most obvious example of this is the absence of lice from certain geographical areas owing to the absence of the host, the distribution of the lice being fundamentally a host one. Thus, none of the 20 or so genera specific to the Tinamidae are found in Africa because there are no tinamous in Africa.

Another reason for the primary absence of a louse genus in a geographical area could be the absence of the genus on the ancestral stock which gave rise to the avian group in that area. Ward (1958) has made an interesting analysis of the louse fauna of the Galliformes and shows that two Ischnoceran genera : *Cuclotogaster* and *Lipeurus*, now represented by many species on the Old World Galliformes, are not found in the New World and suggests that they were not present on the Avian stock which crossed the Behring land bridge. The absence of one of the starling lice in North America could be a modern example of this : Boyd (1951) examined 300 starlings (*Sturnus vulgaris*) from six states in the U.S.A. and found only three of the four species which parasitize this bird in Europe ; *Sturnidoecus sturni* common on the European starling being absent on the introduced bird. The *Coloceras*-complex on the Columbidae may show another case of primary absence, *Campanulotes* being absent in the Ethiopian region and *Coloceras* perhaps absent in the New World ; although both are possibly replaced by related genera. In the Palearctic, Oriental and Australasian regions species of both genera are present, sometimes on the same host individual, showing that the absence in certain regions is not due to competition between the species of the two genera.

The absence of *Quadraceps ridgwayi* in part of the range of its host, *Haematopus ostralegus* (Table III, 3) is probably primary, the parasite having perhaps been acquired from another member of the Charadriiformes by the host stock which gave rise to the southern populations of *Haematopus*.

b. *Secondary Absence.* A species of louse may be found in part only of the range of its host or a genus found only on members of an avian order in certain areas, having become extinct elsewhere. Clay (1949) gave examples of the absence of a host-specific species even within quite small areas, local populations apparently lacking certain species ; presumably in such cases the missing species will be acquired again from neighbouring inter-breeding host populations. However, where the population is isolated then that species may be completely lost from the population. The example given above under Primary Absence of the missing species on North American starlings could equally well be explained as a case of secondary absence by extinction. Another example which could be primary or secondary is shown in the distribution of *Piagetiella* (Amblycera) : the species of this genus are confined to the Pelecaniformes, living in the throat pouches ; they are represented by five species on pelicans and three species parasitic on six species of cormorants (Price 1970). These three species belong to a distinctive species group easily separable from those on the pelicans, indicating that they have not recently been acquired by the cormorants. There is no evidence suggesting that the hosts form a group of closely related species. Table II shows that with the exception of *Phalacrocorax auritus* and *penicillatus*, all the records are found within an area bounded by latitude 0° and 70°S and longitude 80°W and 20°E. It is possible that *Piagetiella* was once found throughout the genus *Phalacrocorax* but has become extinct in other parts of the world. Alternatively, this genus was parasitic on the stock which gave rise to some of the southern cormorants, being secondarily acquired by other unrelated cormorants and carried further north in the New World by *Phalacrocorax olivaceus* and *auritus*. The fact that *Phalacrocorax neglectus* from South Africa is parasitized by the same species of *Piagetiella* (*P. incomposita*) as the two American cormorants (*auritus* and *penicillatus*) suggests, if not a relationship between the hosts, at least a common distribution at one time. It is probable that *Piagetiella* will be found on other cormorants but it can be predicted that these will be cormorants from the subantarctic and adjacent regions ; it is unlikely that it occurs on the European *Phalacrocorax carbo* and *aristotelis*, many of these birds having been examined without result. This distribution may therefore be an example partly of host isolation (see below) and partly of secondary infestation (see below).

TABLE II

DISTRIBUTION OF *Piagetiella* ON *Phalacrocorax*

Piagetiella	*Phalacrocorax*	Locality
caputincisa Eichler	*a. atriceps*	S. Georgia ; S. Orkney Is. ; Graham Land
	a. albiventer	Falkland Is.
vigua (Eichler) (unrecognizable)	*o. olivaceus*	No locality
transitans (Ewing)	*bougainvillii*	Peru
incomposita (Kellogg & Chapman)	*penicillatus*	California
	auritus	Florida, Georgia, Louisiana, Illinois, Minnesota, Quebec.
	neglectus	Dassen Is., South Africa.

Secondary absence may occur where a host species is parasitized by sympatric species belonging to the same genus or by species of a number of related sympatric genera. Such genera are presumably the result of divergence of an ancestral stock on a host group so that the resulting genera are more closely related to each other than to genera found on other host groups. Examples are the *Philoceanus*-complex on the Procellariiformes (comprising about 10 genera), the *Coloceras*-complex of the Columbidae ; the *Goniodes*-complex of the Galliformes and the Ischnocera of the Psittaciformes and of the Bucerotidae. Thus, if one of a pair of sympatric species becomes extinct in part of the host's range and the other in another part (Clay 1949, fig. 4), the two species will show a geographical distribution ; the *Falcolipeurus* species on *Gyps ruppellii* (Table III, 6) may be an example. The same would apply if some of the genera belonging to a generic complex became extinct in part of the host's range ; the North American game-bird fauna and the African and New World pigeon fauna, if not explicable by primary absence, may be examples of this.

TABLE III

PHTHIRAPTERAN TAXA FOUND IN PART OF THE HOST'S RANGE

Host	Phthirapteran Taxa	Locality
1. *Phalacrocorax*	*Piagetiella*	See Table II.
2. Vanellinae	*Saemundssonia africana* Timmermann	Ethiopian ; Oriental; Australasian (Timmermann 1971).
3. *Haematopus ostralegus*	*Quadraceps ridgwayi*	Neotropical ; Australasian (Timmermann 1971).
4. *Sula leucogaster*	*Pectinopygus garbei*	Atlantic
Sula sula	*Pectinopygus garbei*	Atlantic
Sula leucogaster	*Pectinopygus sulae*	Indian Ocean
Sula sula	*Pectinopygus sulae*	Indian Ocean ; Coral Sea (Clay 1964)
5. *Tyto alba*	*Strigiphilus aitkeni* Clay	New World ; Australasian; Oriental.
Tyto alba	*Strigiphilus rostratus*	Palearctic ; Ethiopian (Clay 1966).
6. *Gyps ruppellii*	*Falcolipeurus quadripustulatus*	Egypt, Arabia.
Gyps ruppellii	*Falcolipeurus lineatus*	Somaliland, Tanzania, Nigeria (B. K. Tandan).
7. *Corvus orru*	*Myrsidea schizotergum* Klockenhoff	Queensland, Australia.
Corvus orru	*Myrsidea arafura* Klockenhoff	Northern Territory, Australia.
8. *Podiceps*	*Aquanirmus*	See Table IV.

SECONDARY INFESTATIONS

The establishment of a louse population on a new host may have taken place at any time during the evolution of louse species and host species. It seems probable that establishment is more likely to take place on a new host of the same family or order than on one belonging to a totally unrelated group. That this is so is supported by the cases of geographical distribution discussed below and which may be explained by such intragroup transfers. Little is known about what prevents a louse establishing itself on a new host, but it seems possible that much of the isolation of the Phthiraptera is due more to birds of different species not normally coming into close enough contact for the transfer of lice, than to the louse being unable to establish itself on the new host. Possible methods of inter-specific transfer were given in Clay, 1957.

There are a number of examples of two or more hosts in one geographical area having the same or similar species of parasite whereas this would not be expected from their relationships. An example is the occurrence of a species of *Rhynonirmus* on *Bartramia* (subfamily Tringinae) related to one on *Philohela* (subfamily Scolopacinae) ; the genus *Rhynonirmus* elsewhere being known only from the latter subfamily. If the placing of *Bartramia* in the Tringinae is correct then this may be a straightforward case of secondary infestation (Clay 1961). Another distribution, perhaps explicable by secondary infestation, is that of the species of *Anatoecus* on the flamingoes : *Phoenicopterus antiquorum* and *Phoeniconaias minor*, sympatric in Africa, have the same species of *Anatoecus*, while *Phoenicopterus ruber* and *P. chilensis* in the New World each have a distinct species. It would be expected that *P. minor*, considered generically distinct, would have the different parasite. Alternatively, this distribution could be explained by divergent evolution of the New World lice or a mistaken assessment of flamingo relationships. However, that secondary infestation may have taken place between the two African species of flamingoes is supported by the distribution of the species of another genus parasitic on this host family. Tandan & Brelih (1971) have shown that the three species of *Phoenicopterus* (*antiquorum, ruber* and *chilensis*) are parasitized by one species [(*Anaticola phoenicopteri* (Coinde)], whereas *Phoeniconaias minor* has this species and also a distinct species of the same genus (*Anaticola dissonus*), the two never having been found together on the same host individual. It is suggested that *phoenicopteri* evolved on *Phoenicopterus* and *dissonus* on *Phoeniconaias* and that subsequently the former species became secondarily established on *P. minor*. The wide distribution of *Saemundssonia africana* (Table III, 2) on the southern populations of the Vanellinae may be due to secondary infestations on some of the hosts.

Tendeiro (1962) has analysed the distribution of the louse genus *Columbicola* parasitic on the Columbidae and shown that the distribution of some species is more a geographical one than a host one and that these can be attributed to secondary infestations.

There are other examples, probably due to secondary infestation, but in which the transfer of lice must have taken place at a time when the distribution of the host was different. Thus, *Corvus kubaryi* (Corvidae) on Guam Island (Marianas) has an established population of a louse species belonging to a genus normally parasitic on the Rallidae, the species *Rallicola insulana* (Carriker) also being found on a *Porphyrio* (Rallidae); at the present time there is no overlap in distribution of the possible hosts (Clay 1953). Another example is the unexpected occurrence of *Actornithophilus hoplopteri*, a parasite characteristic of the Vanellinae, on *Charadrius vociferus* (see Clay 1962). The absence of members of the Vanellinae in North America at the present time suggests extinction or changes in distribution of hosts from which this louse might have been acquired by *Charadrius vociferus*. The same may apply to the Coliiformes in Africa which are parasitized by a genus *Colilipeurus* apparently most nearly related to *Falcolius* on *Microhierax* (Falconiformes) found in the Oriental region (Clay 1955). Relationship between the hosts is unlikely but if the distribution is due to secondary infestation then it must be postulated that the two host groups have at some time been sympatric. As both parasite genera now comprise a number of host-specific species, it must be presumed that the transfer preceded the divergence of the hosts.

GEOGRAPHICAL ISOLATION OF HOST

The present distribution of *Chelopistes* can be explained by the isolation of the host group on which it evolved. Ward (1958) suggests that this genus, now widely distributed on the Cracidae, Odontophorinae and the Meleagrididae, evolved from a *Goniodes* stock in N. America during the Tertiary and after the re-union of North and South America in the Pliocene, moved southwards to Central and South America on such genera as *Odontophorus*. However, a study of the morphology of *Chelopistes* suggests that it (as well as *Labicotes*) is a derivative of *Oxylipeurus*, although it occupies the *Goniodes*-niche. Therefore, it seems possible that only the ancestral *Oxylipeurus* (among the Ischnocera) reached S. America, perhaps on an early Cracidae stock, which either crossed before the severance of connections between North and South America in the Paleocene or as one of Simpson's ' Old Island Hoppers ' (Simpson 1950). During this isolation *Chelopistes* evolved from an *Oxylipeurus* stock to occupy the niche used by *Goniodes* in many of the Nearctic and Palaearctic birds. With the re-uniting of the Americas during the late Pliocene and the movement south of other families of birds, *Chelopistes* became established on the Odontophorinae and Meleagrididae. This would explain its absence on members of the Odontophorinae north of Mexico and the absence of *Goniodes* on the Cracidae. Thus, the present distribution may be the result of divergence on an isolated host group, with some subsequent secondary establishment in other host groups, all taking place during the early evolution of the hosts. This shows the difficulty of using host-parasite relationships to elucidate the phylogeny of the higher categories of birds. However, such cases if correctly interpreted may throw some light on the origins and migrations of avian groups.

Another unusual type of distribution perhaps explicable by host isolation is that of *Aquanirmus* on the grebes (Podicipitiformes). Edwards (1965) has shown that two of the grebe species common to Europe and North America are parasitized by species of *Aquanirmus* belonging to different species groups on the two sides of the Atlantic (Table IV). In addition, *Podiceps cristatus* is parasitized in Europe by *A. podicipis* (Denny) belonging to the *colymbinus* species group and

Table IV

The species of *Aquanirmus* on *Podiceps*

Podiceps	Locality	*Aquanirmus*	Species Group
auritus	Europe	*colymbinus*	*colymbinus*
	N. World	*bucomfishi* Edwards	*bahli*
nigricollis	Europe	*colymbinus*	*colymbinus*
	N. World	*americanus* (Kell. & Chap.)	*bahli*
ruficollis	Europe	*podicipitis*	*colymbinus*
	S. Africa, India	*bahli* Tandan	*bahli*
cristatus	Europe	*podicipis*	*colymbinus*
griseigena	Europe .. .. N. World	*emersoni* Edwards	*emersoni*
dominicus	N. World	*chamberlini* Edwards	*bahli*

Podiceps griseigena on both sides of the Atlantic has the same species of *Aquanirmus*, belonging to a species group otherwise found on North American grebes. If, as has been suggested, the grebes originated in North America, it is possible as Edwards says that only one of the grebes arriving in Europe had the *colymbinus* stock and that the others acquired it by secondary infestation. However, another perhaps more likely explanation is that the *colymbinus* stock was the original stock on all the grebes and on the European grebes it diverged little, perhaps now representing only a polytypic species, whereas on the North American stock greater divergence took place; it should be noted that the differences between the species groups of *Aquanirmus* are small. If this is a correct hypothesis, the following deductions can be made: a. *Podiceps griseigena* became established in Europe at a later date than the other species of *Podiceps*. b. The possibility of a New World *ruficollis* stock, now extinct, which gave rise first to the Northern European *ruficollis* parasitized by the *colymbinus* species group and at a later date to the African and Oriental *ruficollis* populations after it had acquired *bahli* from a New World grebe. Specimens from *ruficollis* in other parts of its range might throw further light on its distribution routes. Isolation of host may be responsible for the two species of *Strigiphilus* parasitic on the widely distributed *Tyto alba* (Example 5, Table III) and may indicate the distribution routes from the centre of origin of this bird.

Some apparent cases of geographical distribution of lice are probably host distributions due to the hosts in one region being closely related to each other, having evolved from a common stock in that area. *Trinoton aculeatum*, for instance, is parasitic on *Dendrocygna viduata* in South America and South Africa and on *D. bicolor* and *D. autumnalis* in the New World, while each of the species *D. javanica* (Oriental), *D. arcuata* (Australia, Papua) and *D. eytoni* (Australia) are parasitized by a separate species (Clay 1963). This is probably a host distribution, the divergence of the lice being dependent on the time and divergence of the hosts.

Other cases which may be either host or geographical distribution are those in which two subspecies of host are each parasitized by a species of louse, as for example, the occurrence of *Heleonomus semiluctus* on *Balearica p. pavonina* in west Africa and *H. cornutus* on *Balearica pavonina gibbericeps* in east Africa (Price 1970). The specific differences may have arisen during the geographical isolation of the louse populations or as an adaptation to some difference in the host's external characters, arising during the isolation of the hosts themselves. The distribution of *Myrsidea* on the subspecies of *Corvus macrorhynchos* may be partly a geographical and partly a host one (Klockenhoff 1969). In the case of *Corvus orru cecilae* in Australia (Table III), the same subspecies is parasitized by one species of *Myrsidea* in the Townsville area, Queensland and by another species (or a distinct subspecies) at Port Essington, Northern Territory (Klockenhoff 1972).

UNEXPLAINED DISTRIBUTIONS

The explanation of the distributions discussed above are highly conjectural; in the following examples any conjecture at all may be unwise: a. Example 4 in Table III in which *Sula sula* and *Sula leucogaster* (Pelecaniformes) share the same parasite in the Atlantic and share a different one in the rest of their range. Some possible explanations for this were given in Clay, 1964. b. The distribution of *Degeeriella regalis sens. lat.* on the Milvinae; *Buteo jamaicensis*, *B. swainsoni* and *B. galapagoensis*; *Haliaeetus vocifer*, *H. leucoryphus* and *Gypohierax angolensis* (see Table I for geographical range). This may be an example of secondary absence by extinction of one of a sympatric pair, the *fulva* group taxa having become extinct on these hosts, and the *regalis* group taxa on others of the Falconiformes. c. Two similar species of *Struthiolipeurus*, one on the ostrich (*Struthio*) in Africa, the other on the *Rhea* in South America, the genus *Struthiolipeurus* being found only on these two host genera. This could be explained either by relationship between the hosts or by overlap of distribution at some time. d. The occurrence of *Chelopistes* on *Lerwa lerwa*. As shown above *Chelopistes* is found on the New World families Cracidae, Odontophorinae and the Meleagrididae and this distribution suggests that its origin and divergence took place in the New World. Why therefore does a typical member of the genus turn up on *Lerwa* (subfamily Phasianinae) now restricted to Afghanistan and the Himalaya east to the mountains of Szechuan? *Chelopistes* is a distinctive genus and the species on *Lerwa* resembles the other species too closely to suggest that it could have arisen by parallel evolution. It must be presumed that *Chelopistes* was found on hosts with a continuous distribution from the New World to the Oriental region, of which only that on *Lerwa* in a small part of Asia remains. It may be relevant that also parasitic on *Lerwa* is a species of *Lagopoecus* which does not resemble the species-group typical of the Tetraonidae and found on some members of the Phasianinae, but is more similar to the species found on the Odontophorinae, especially to *Lagopoecus numidianus* (Denny) from *Colinus virginianus*. This group of species of *Lagopoecus* parasitic on the Odontophorinae shows rather diverse characters especially in the form of the male genitalia, so that the fact that those of the *Lerwa*-infesting species are distinct would not rule out a relationship.

CONCLUSIONS

The present distribution of the avian Phthiraptera is the result of a complex of circumstances and factors operating at all stages of the evolution of the host and parasite and involving host specificity, geographical isolation, extinction, secondary infestations and the various changing ecological factors in the environment of the louse provided by the body of the bird. The ornithologist may benefit from a knowledge of the distribution of the Phthirapteran parasites, not only from the light this may throw on bird phylogeny, the phylogenetic relationship being the basic one, but the evidence provided of early migrations, dispersal routes (Table V) and of former distributions. More extensive collecting and closer study of the genera, based on detailed revisions, are revealing and will reveal further examples of geographical distribution and perhaps help to elucidate some of the present inexplicable cases.

TABLE V

SPECIES AND GENERA OF PHTHIRAPTERA SHOWING DISCONTINUOUS GEOGRAPHICAL DISTRIBUTION

Louse & Host Group		New World	Austra-lasian	Ethiopian	Oriental	Palearc-tic
Physconella Columbidae	..	+	+	—	—	—
Quadraceps ridgwayi *Haematopus ostralegus*	..	+	+	—	—	—
Strigiphilus aitkeni *Tyto alba*	..	+	+	—	+	—
Aquanirmus bahli *Podiceps*	..	+	?	+	?	—
Struthiolipeurus *Struthio, Rhea*	..	+	—	+	—	—
Saemundssonia africana Vanellinae	..	—	+	+	+	—
Piagetiella incomposita Phalacrocoracidae	..	+	—	+	—	—
Trinoton aculeatum *Dendrocygna*	..	+	—	+	—	—
Chelopistes Galliformes	..	+	—	—	+	—
Strigiphilus rostratus *Tyto alba*	..	—	—	+	—	+

? No records, possible host present.

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The Migration of the Gannet into the Mediterranean[1]

A. LANDSBOROUGH THOMSON

This paper develops a particular aspect of a more general study of the migration of the Gannet *Sula bassana* based on the recovery records of birds ringed at breeding stations round the coasts of Great Britain and Ireland (Thomson 1974). That study is itself a reassessment of a situation earlier analysed by use of records representing only about one-eighth of the number latterly available (Thomson 1939). It is assumed that the ringing data, with due allowance for probable fluctuations in death-rate, are reasonably representative of the geographical incidence of the birds at different ages and seasons. On this assumption, the ringing data provide numerical indications such as cannot be derived from general statements of distribution based on uncoordinated observational evidence. The records have been placed at the writer's disposal by the British Trust for Ornithology.

SOURCE OF THE DATA

Gannets native to, or breeding at, stations round the British and Irish coasts represent a large proportion of the eastern North Atlantic population of the species. Relatively little ringing of these birds has been done at the large breeding stations off Iceland and in the Faeroe Islands; and others are of negligible size. The largest British station, that on St Kilda, has also contributed nothing, owing to its inaccessibility. Most of the birds here considered were ringed at one or other of three offshore islands :—the Bass Rock in the Firth of Forth, on the east coast of Scotland (56°0′4N, 2°38′W); Ailsa Craig in the Firth of Clyde, on the west coast of Scotland (55°23′N, 5°07′W); and Grassholm in the Irish Sea, off Pembrokeshire, SW Wales (51°44′N, 5°29′W.). Other stations off the coasts of Scotland and Ireland have yielded a few records. No differences in migratory behaviour between birds from the several localities have been detected, except that those from Grassholm tend—as might be expected—to appear in Biscay waters somewhat earlier in the autumn than those from the Scottish stations.

The records used in the main study numbered 1761, after discarding those considered to be non-viable owing to uncertainty in the parti-

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culars or because the birds had never flown. The records had resulted from the ringing of 32,681 birds, mostly as nestlings (*pulli*), up to and including 1968, and recoveries therefrom up to the end of 1971—a yield of almost 5·4 per cent. Of these records, 46 were from the Mediterranean; and to these are here added 5 others of more recent date which there is no special reason for excluding in the present context.

CONCLUSIONS OF THE GENERAL STUDY

The main study shows a dispersal of the birds in northern waters, and a partial migration southwards along the Atlantic seaboards of western Europe and of northern and tropical Africa; the extreme records are from Portuguese Guinea (just south of 12° N). From this movement there is the branch into the Mediterranean Sea, obviously through the Straits of Gibraltar, which is here of more detailed concern.

The other principal finding is that birds in their first year of life are migratory in markedly higher degree than those in their second year, taken alone, or than all older birds taken together. That there is any further decrease in the migratory urge after the second year is doubtful, despite some slight appearance of this in the figures. The picture is obscured by the fact that some of the immature birds—in a species which does not breed until four or five years old—do not return to northern waters in summer. A close examination of the Mediterranean records seems to throw some light on this point.

OBSERVED DISTRIBUTION IN THE MEDITERRANEAN

Gannets are seen in the western Mediterranean in winter, and less frequently at other seasons; Jenkins (1944) recorded about 150 fishing off Algeria in November, but such numbers are considered to be exceptional. Referring generally to North Africa, Etchécopar & Hüe (1967) state that 'In the Mediterranean the usual easterly limit is in the region of Tripoli, but it has been seen exceptionally in Egypt'—this last not improbably refers to the bird recorded by Cornish (1934). On the other hand, Hardy (1946) has published a circumstantial statement that the Gannet is a 'fairly common winter visitor to the Palestine coast', appearing under certain weather conditions in numbers up to 50; this statement, and later supporting evidence, seems to have been overlooked by subsequent writers. The Bannermans (1971) rate it as a rare visitor to Cyprus, where it had not been recorded before 1965.

Spano (1965, 1966) has listed and analysed the 100 then known instances of Gannets being taken in Italy, and a further 25 sight records.

Although these occurrences are spread throughout the year, most of them fall in the months from November to March inclusively, with a secondary peak in June (when, in contrast with ringing recoveries, there are about equal numbers of *adulti*, *semi-adulti* and *giovani*). The largest concentrations of records are in the Gulf of Genoa and off the north coast of Sicily; but there are occurrences up to the head of the Adriatic and several inland (Po valley, etc.).

MEDITERRANEAN RECOVERIES OF RINGED BIRDS

Numbers: As already stated, there are 51 records of Gannets ringed at breeding stations in the British Isles and recovered in the Mediterranean— 46 included in the main study to which reference has been made, and 5 of more recent date. The 46 recoveries may be compared with the inclusive total of 747, in the main study, south of Ushant (Ouessant; 48°28′ N); Mediterranean recoveries thus comprise just under 6·2 per cent of all those showing migration southwards from home waters.

Age incidence: All but one of the recovered birds were ringed as nestlings (*pulli*), and these were recorded in the Mediterranean in the following years of life:

1st	2nd	3rd	4th	5th	6th
24	15	6	2	2	1

Years of life are reckoned from 1 May, as in the main and earlier studies, although during May and June of the first year the birds are at most in the egg or in the nest and recoveries are nil.

The figures show the usual pattern of diminishing returns as the total 'at risk' decreases with annual mortality. The ratio of second-year to first-year birds (15/24=62·5 p.c.) is, however, about double that found in the generality of recoveries south of Ushant. (133/458=29·0 p.c.). This may well be a result of first-year birds remaining in the Mediterranean through the next summer; the alternative that second-year birds have a special proclivity for migrating into the Mediterranean seems to be highly improbable in the light of all the evidence.

Geographical incidence: The Mediterranean may be conveniently divided into eight longitudinal sectors, each covering five degrees—rather more at the two extremes; a distinction can also be made between the north and south sides of the Sea within these sectors. The recoveries can then be tabulated as follows:

Sector	W of 0°	0-5°E	5-10°	10-15°	15-20°	20-25°	25-30°	E of 30°
North side	13	6	—	4	2	—	—	1
South side	14	6	2	2	—	—	—	1
Total	27	12	2	6	2	—	—	2

It can be seen at a glance that the movement from the Atlantic into the Mediterranean is of the nature of a dispersal, numbers falling off rapidly with distance, rather than a migration with a definite eastward urge.

Rather more than half of the total number of records fall in the first (slightly enlarged) sector, west of 0°, and are about equally divided between northern and southern sides of the Mediterranean. On the north side 13 records are spread from Gibraltar along the south-eastern coast of Spain as far as Valencia ; on the south side 14 records range from just south of Ceuta along the northern coast of Morocco and the coast of western Algeria (Oran, etc.).

Approximately another quarter of the total fall in the second sector (0-5°E), equally divided between the north and south sides. On the north, all 6 records relate to that part of the coast of France lying west of the Rhone delta ; 6 records are from the south side, which comprises the middle part of the coast of Algeria (Algiers, etc.)

In the third sector (5-10°E), there are no records from the north side of the Mediterranean, while on the south there are single records from eastern Algeria (Bône) and western Tunisia (Bizerta) respectively.

In the fourth sector (10-15°E) there are, on the north, 4 records from the western side of Italy (Elba ; Naples) and of Sicily (Palermo ; Agrigento) ; and on the south one record from eastern Tunisia (Sfax) and one from western Libya (Tripoli). In the fifth sector (15-20°E) there are two records on the north, from eastern Sicily (Gulf of Catania) and south-eastern Italy (Gulf of Taranto).

Beyond that there are just two records, one on the north and one on the south, from the extremity of the (slightly enlarged) eighth sector (east of 30°E) :

101.0734 Bass Rock (pull.) 1964 : *ca.* 5.iii.65, Gulf of Iskanderun S.E. Turkey (Asia Minor), 36°40′N, 36°00′E.

104.7812 Ailsa Craig (pull.) 1966 : 3.iii.71, Ashdod, Israel (near Gaza), 31°48′N, 34°38′E.

Seasonal Incidence : The month by month distribution of the Mediterranean recoveries, showing those in the first two years of life separately, is as follows :

	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
First year	—	—	—	—	1	4	10	5	1	—	2	2
Second year	1	2	3	1	1	—	1	3	—	1	2	—
Later years	2	1	1	—	—	—	1	1	2	2	1	—
	3	3	4	1	2	4	12	9	3	3	5	2

All the recoveries east of 5°E were in the period November-March inclusively.

A peculiar point emerges from a more detailed examination of the recoveries of first and second year birds in the first two sectors ; beyond that, as regards both age and distance, the figures become rather small. No first-year birds have been recovered on the north side in the second sector, whereas there have been 5 recoveries of second-year birds, 3 of them in July and 1 in August. It seems unlikely that these birds had migrated in that year from northern waters, and more probable that they had remained in the Mediterranean from the year before (other evidence of which has already been mentioned). An apparent tendency to move northwards into the Gulf of Lions in summer is of interest, especially as that area is not otherwise productive of records (a second-year bird in November, and a third-year bird in June).

COMPARISON WITH THE BALTIC

The Baltic Sea (*Ostsee*) appears to offer a comparable opportunity for a lateral movement eastwards at right angles to the general southward migration. In fact, however, the species is uncommon in the Baltic and the number of ringing records from there is almost negligible. There are numerous records of British-ringed Gannets from the eastern and south-eastern coasts of the North Sea, and into the Skagerrak and Kattegat. But with one exception there are no records showing penetration beyond what one may call the Baltic approaches ; the extreme case, perhaps slightly overstepping that definition, is of a Grassholm bird recovered in March of its second year in the Gulf of Lübeck, off the coast of Mecklenburg. The definite exception is a Bass Rock bird (507 318) recovered in summer, in June of its fifth year, in the Sovetsk region of Lithuania, 55°05′N, 21°52′E.

There are obvious reasons for regarding the Baltic Sea as a relatively inhospitable area. Parts of it are frozen over in winter ; and elsewhere floating ice may be a hazard to birds plunging from a height. According to A. Wheeler of the British Museum (Natural History), in a personal communication, lack of food fishes is not likely to be a factor ; most of the species which the Gannet is known to take in British waters are found in the Baltic. He suggests that turbidity of the water, in a shallow sea fed by numerous silt-bearing rivers, may often make it difficult for flying birds to see fish swimming beneath the surface layers.

SUMMARY

The now abundant recovery records of *Sula bassana* ringed at British breeding colonies give a numerical indication of the geographical incidence of the birds according to age and season.

From the partial southward migration along the Atlantic seaboards of Europe and Africa, notably in the first year of life, there is a lateral branch into the Mediterranean Sea. This is a relatively small movement, represented by little more than six per cent of the total number of records south of Ushant (taken as the southern limit of home waters). It is more of the nature of a dispersal, numbers decreasing rapidly with distance, than a definite migration with an eastward urge ; the spread takes place along both the north and the south sides of the Mediterranean, and there are exceptional records from the far corners of the Levant.

There is a suggestion that first-year migrants remain in the Mediterranean through the following summer in higher proportion than in the Atlantic ; and that there is then a movement northward into the Gulf of Lions.

There is, comparable with that into the Mediterranean, virtually no lateral movement eastward into the Baltic Sea.

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The role of birds in the natural foci of tick-borne arboviruses in Western Siberia [1]

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In Western Siberia the existence of two arbovirus infections communicated by ixodid ticks has been determined : the Russian spring-summer tick-borne encephalitis (RSSE) and the Omsk hemorrhagic fever (OHF) closely related to it, discovered in 1946-48.

The two viruses belong to the antigenic tick-borne encephalitis complex whose representatives are found in many localities at great distances from one another in Eurasia and North America.

The discovery in India (Work, Trapido and others) of the Kyasanur forest disease, which is etiologically and clinically close to RSSE, showed the possibility of virus exchange between India and Western Siberia, occurring most likely on account of the migration of birds between India and Siberia. Thus, the region of Siberia-India (and more widely South-East Asia) has been selected as a typical area for studying the role of migrating birds in spreading arboviruses on the virus models of tick-borne encephalitis complex. Theoretically, within this region, besides the exchange of arboviruses of the spring-summer tick-borne encephalitis complex, there is the assumption of possible arbovirus transfer of other antigenic groups northward of the Himalayas from South-East Asia and Africa.

Very important in solving these problems can be named the studies on migrating birds in India that have been carried out under the guidance of Dr Sálim Ali.

As we are concerned with viruses communicated by ixodid ticks, the ascertaining of biocoenotic relations of birds with ticks in the foci of corresponding infections will be of foremost interest. This article brings out the basic results of our comparative studies of biocoenotic relations of birds with ticks and viruses in the foci of tick-borne encephalitis and Omsk hemorrhagic fever in Western Siberia.

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The principal transporters of the said viruses are two basic West-Siberian species of ixodid ticks: *Ixodes persulcatus* P. Sch. (taiga foci of tick-borne encephalitis) and *Dermacentor pictus* Herm (forest-steppe foci of OHF). In Western Siberia spontaneous infectivity with both viruses has been repeatedly determined in the said two species of ticks.

THE IMPORTANCE OF BIRDS IN THE HOST RANGE OF TICKS *Ixodes persulcatus* AND *Dermacentor pictus*

Our observations of many years, together with the available data of other authors, have shown that the role of birds in harbouring ticks is quite different for each of the two basic West-Siberian species (see Table 1).

TABLE 1

HOST-RANGE OF *I. persulcatus* AND *D. pictus* IN WESTERN SIBERIA

	Number of species of vertebrates acting as tick hosts	
	I. persulcatus	*D. pictus*
Amphibia ..	1	1
Reptilia ..	3	2
Aves ..	77	6
Mammalia ..	59	53
Total ..	140	62

The said species of ticks differ basically in that the *I. persulcatus* feeds broadly on birds and mammalia, while *D. pictus* feeds mostly on mammalia (rodents and insectivorae) and where birds, amphibia and reptilia serve only as accidental hosts. In the present instance the question concerns the feeding of larvae and nymphs of ticks, as the imagines of both species feed on large mammalia, principally on cattle.

An idea of the role of different species of birds in harbouring *I. persulcatus* is given in Table 2.

It can therefore be said that the number of bird species acting as tick-carriers, will be the greater the greater the area of forested territory, that is, from 23 species in large taiga areas to two species on the terraces on the flood-lands of taiga rivers, where the vegetation is represented by shrubs and thinned groves. The leading role belongs to *Anthus trivialis*, *Turdus pilaris* and *Emberiza citrinella* which become regularly

TABLE 2

BIRDS ACTING AS CARRIERS OF *I. persulcatus* TICKS IN DIFFERENT AREAS OF TERRITORY WHERE TICK-BORNE ENCEPHALITIS IS ENDEMIC (FOREST-STEPPE ON FOOTHILLS AND HIGHLAND TAIGA OF WESTERN SIBERIA)

Species of birds	Taiga	Pine forest along rivers	Forest-steppe	Terraces on the flood-lands
1. *Tetrao urogallus* L.*	+	—	—	—
2. *Lyrurus tetrix* L.*	—	+	—	—
3. *Tetrastes bonasa* L.**	+	—	—	—
4. *Dryobates major* L.	—	+	—	—
5. *Anthus trivialis* (L.)**	+	+	+	+
6. *Motacilla caspica* (Gmelin)	+	—	—	—
7. *Carpodacus erythrinus* (Pall.)*	+	+	—	—
8. *Fringilla montifringilla* L.*	+	—	—	—
9. *Fringilla coelebs* L.*	—	+	—	—
10. *Pyrrhula pyrrhula* L.*	+	—	—	—
11. *Passer montanus* (L.)	—	+	—	—
12. *Emberiza aureola* Pall.*	+	+	+	+
13. *Emberiza rustica* Pall.	+	—	—	—
14. *Emberiza leucocephala* S. G. Gmelin**	+	+	—	—
15. *Emberiza citrinella* L.**	+	+	+	—
16. *Sitta europaea* L.	+	+	—	—
17. *Parus major* L.	—	+	—	—
18. *Erithacus svecicus* (L.)	—	—	+	—
19. *Luscinia luscinia* L.	+	—	—	—
20. *Luscinia calliope* (Pall.)*	+	+	—	—
21. *Saxicola torquata* (L.)	—	+	—	—
22. *Turdus ruficollis* Pall.**	+	—	—	—
23. *Turdus pilaris* L.**	+	+	+	—
24. *Turdus philomelos* Brehm	+	—	—	—
25. *Turdus iliacus* L.	+	—	—	—
26. *Phoenicurus phoenicurus* (L.)*	+	—	—	—
27. *Prunella montanella* Pall.*	+	—	—	—
28. *Sylvia communis* Lath.	+	—	—	—
29. *Phylloscopus trochilus* (L.)	+	—	—	—
30. *Lanius cristatus* L.	+	+	—	—
31. *Garrulus glandarius* (L.)	+	—	—	—
Total number of species of tick-carriers	24	15	5	2

* Uncommon species of birds regularly infested by ticks.

** Common species of birds regularly infested by ticks.

infested, and are the most numerous on all the mentioned areas, or at least on three of the four observed. A substantial role also belongs to *Emberiza aureola* which, though less numerous, is nevertheless regularly infested in all of the areas. The extent to which various bird species are infested depends on the peculiarity of their food, as well as the average time spent daily on the ground.

The number of bird species taking part in the feeding of ticks *I. persulcatus* varies in different areas, and depends on the general reserve of immature stages on the given territory (Table 3).

TABLE 3

PERCENTAGE OF BIRDS INFESTED BY TICKS ; THE RESERVE OF IMMATURE STAGES OF *I. persulcatus*, AND THE NUMBER OF BIRD SPECIES ACTING AS TICK-CARRIERS IN DIFFERENT TYPES OF FOCI

Index		Taiga	Pine forest along rivers	Forest-steppe	Terraces on the flood-lands
Reserve of the immature stages *I. persulcatus* (Total index of feeding in the average per season)		20·8	12·8	10·0	5·0
Number of bird species acting as tick-carriers	(*a*) sporadically infested by ticks	9	6	1	2
	(*b*) regularly infested by ticks	8	5	1	—
	(*c*) mass infestation by ticks	6	4	3	—
	In all	23	15	5	2
Average percentage of birds infested by ticks		46·5	40·0	16·2	1·8

Birds become particularly infested in the years when the number of small mammals is low, and when they serve to fill up the deficiency in hosts (Shilova 1966). This shows the substantial role birds play in keeping up the number of ticks *I. persulcatus*.

Absolutely different relations obtain in areas where *D. pictus* predominates. Birds are infested with ticks of this species at an average of only 0·1-0·9% (forest-steppe of West Siberian lowland). Unitary nymphs of *D. pictus* have been collected from *Tringa ochropus*, *Anthus trivialis*, *Motacilla flava*, *Emberiza citrinella*, *Emberiza schoeniclus* and *Turdus philomelos*. It follows from this that birds may serve only as accidental hosts of *D. pictus*, which nevertheless does not signify their exclusion from the virus circulation (see below).

The fact that *D. pictus* does not parasitize on birds has been repeatedly noted by a number of authors who have worked in Western Siberia, but has not so far received satisfactory explanation.

BIRDS, AS THE FACTOR OF FORMATION OF MIXED IXODID TICK FAUNA AND THE FACTOR OF COMBINING NATURAL FOCI OF VARIOUS INFECTIONS

The retention of virus population on a given territory is ensured by its reproduction during the circulation process within the range of conforming biocoenosis, as well as by viruses brought in with arthropods and vertebrates. Here a certain role must belong to birds, capable of promoting virus exchange between foci not only within limited areas, but over large distances as well (migrating birds). Birds may act as the factor of formation of mixed tick fauna, and of combining natural foci of various tick-borne infections.

In Western Siberia some Altai regions are of special interest, where the tick-borne encephalitis fauna is represented by five species of ticks : *I. persulcatus*, *I. apronophorus*, *Haemaphysalis concinna*, *D. pictus* and *D. silvarum*. *Ixodes persulcatus* and *Haemaphysalis concinna* can be named as the most numerous tick species in the biotopes investigated. These species, in the present case, are epidemiologically significant as being the carriers of tick-borne encephalitis and tick-borne typhus fever (Serdyukova 1956 ; Shaiman *et al.* 1966), and they regularly parasitize on birds (see Table 4).

TABLE 4

SPECIES OF BIRDS INFESTED BY TICKS IN THE INVESTIGATED AREAS OF ALTAI

Bird species	Species and stages of ticks					
	I. persulcatus			*H. concinna*		
	larvae	nymphs	imagines	larvae	nymphs	imagines
1. *Accipiter nisus* L.	+	—	—	—	—	—
2. *Alauda arvensis* L.	—	—	—	+	+	—
3. *Anthus trivialis* L.	+	+	+	+	+	—
4. *Motacilla caspica* (Gmelin)	—	+	—	—	—	—
5. *Turdus pilaris* L.	+	+	+	+	+	—
6. *Turdus philomelos* Brehm	+	—	—	—	—	—
7. *Turdus iliacus* L.	+	—	—	—	—	—
8. *Turdus ruficollis* Pallas	+	—	+	—	—	—
9. *Sylvia communis* Latham	—	+	—	—	—	—
10. *Parus major* L.	—	+	—	—	—	—
11. *Emberiza citrinella* L.	+	+	+	+	+	—
12. *Emberiza leucocephala* S. G. Gmelin	+	+	+	+	—	—
13. *Emberiza spodocephala* Pallas	—	+	—	—	+	—
14. *Coccothraustes coccothraustes* (L.)	—	—	—	+	—	—
15. *Pyrrhula pyrrhula* L.	+	—	—	—	—	—
16. *Carpodacus erythrinus* (Pallas)	+	+	—	—	—	—
17. *Fringilla coelebs* L.	+	+	—	—	—	—
18. *Sturnus vulgaris* L.	—	—	+	+	—	—
19. *Nucifraga caryocatactes* (L.)	+	—	—	—	—	—
In all		17			8	

Ixodes persulcatus has been found on 17 bird species in the immature stage and as imago. *Haemaphysalis concinna* has been found only on eight bird species and exclusively as larvae and nymphs. Hence, *I. persulcatus* attacks birds more readily than *H. concinna*. Table 5 shows the state of infestation of birds and small mammalia by these two tick species in different biotopes.

TABLE 5

COMPARATIVE DATA ON THE INFESTATION OF SMALL MAMMALIA AND BIRDS BY TICKS

(Observations made in Altai)

Animal group and area of observation	Number of animals examined	Ixodid ticks collected (L+N+I)	*I. persulcatus*				*H. concinna*			
			% of infestation				% of infestation			
			L	N	I	in general	L	N	I	in general
Small mammalia										
Secondary birch-aspen-pine forests	191	341	41·3	6·8	0	41·3	2·4	0	0	2·4
Foothill forest-steppe	126	146	34·1	2·3	0	34·1	27·7	31·1	0	29·9
Birds										
Secondary birch-aspen-pine forests	157	643	28·6	26·7	16·5	39·1	8·9	17·1	0	26·0
Foothill forest-steppe	33	55	3·0	3·0	0	6·0	18·1	24·2	0	30·3

Nymphs of *H. concinna* in secondary forests have been found only on birds; small mammalia were left practically uninfested. The birds, obviously, become parasitized with this tick beyond the bounds of secondary forests, and, in the present case, in the foothill forest-steppes, where *H. concinna* are much more numerous than under the cover of the forest. The foothill forest-steppes, due to their mixed character of biotopes, concentrate birds that act as hosts for *H. concinna* (*Turdus pilaris*, *Anthus trivialis*, *Emberiza leucocephalos*, *E. citrinella*). The constant daily shifting of certain bird species (search of food for young, daytime location, etc.) from foothill forest-steppes to the secondary forests serves to transfer *H. concinna* into the forest biotopes.

At the same time there occurs the transport of ticks from the secondary forests to the foothill forest-steppes. In this respect it is especially interesting that birds of the sparrow family are parasitized not only by larvae and nymphs of *I. persulcatus*, but by the imago of the latter as well. In connexion with the discovery in Altai of the tick *Ixodes pavlovskyi*, similar to *Ixodes persulcatus* and co-existing with it in the same biotopes, and owing also to the inclination of *I. pavlovskyi* to feed on birds, Filippova & Ushakova (1967) suggested that the imagines of ticks in our collections from birds belong mostly to *I. pavlovskyi*. The leading role of *Ixodes* sp. as carriers in secondary forests belongs to *T. pilaris* (infestation up to 69%), as well as to *E. citrinella* and *E. leucocephalos* (infestation up to 50%).

These observations allow us to consider birds as one of the factors providing the formation of mixed ixodid fauna in the said locality on the boundary between the forest-steppe and the taiga. *I. persulcatus* and *H. concinna* are the vectors of tick-borne encephalitis and Asian tick-borne rickettsiosis, and birds, as it can be seen, play a definite role in forming combined foci of these infections in Western Siberia (Netsky, Shaiman).

According to observations made by H. Hoogstraal *et al.* (1963) the exchange of ixodid ticks by migrating birds is also possible at great distances. In this case the repeated bringing in of even single ticks may be of significance, while its possibility is predetermined by the regular mass migration of birds along evolutionally established routes.

Our observations show that ticks of the local ixodid fauna may take part in irradiating pathogens brought in from a definite spot to adjacent territories. This is, apparently, most probable where the biotope changes and in the presence of ticks that actively attack birds.

THE ROLE OF BIRDS IN THE CIRCULATION OF TICK-BORNE ARBOVIRUSES WITHOUT THE PARTICIPATION OF IXODID TICKS

Participation of birds in the circulation of West Siberian tick-borne arboviruses (tick-borne encephalitis and Omsk hemorrhagic fever) is effected not only by the attacks of ixodid ticks, but by other ways in which birds get infected. Thus, in the forest foci of RSSE, *I. persulcatus* regularly feed on birds (21 to 40% of the birds are parasitized by ticks), on the other hand, in forest-steppe foci of OHF *D. pictus*, which is the dominant species there, leaves the birds practically untouched (only 0·1 to 0·9% of the birds are parasitized).

At the same time Matyukhin and Fedorova *et al.* (1966) have shown that in the forest foci of RSSE, as well as the forest-steppe foci of OHF, there occurs wide contact of birds with viruses. The immune layer against viruses of the RSSE complex in forest-steppe foci makes up 22·9%, and in the forest-steppe areas from 13·4 to 22·3%. As a whole, in the forest-steppe foci of OHF out of 606 specimens of birds (77 species) antibodies to viruses of the RSSE complex were found on 87 birds (32 species) (see Table 6). In the latter case the rare instances of ticks attacking birds are, apparently, insufficient to maintain the immune layer on said level.

TABLE 6

BIRDS IN FOREST-STEPPE FOCI OF OHF WITH ANTIBODIES TO VIRUSES OF THE RSSE COMPLEX (MATYUKHIN, FEDOROVA *et al.* 1966)

1. *Anthus novaeseelandiae* Gmelin
2. *Anthus trivialis* (L.)
3. *Acrocephalus agricola* (Jerdon)
4. *Motacilla alba* L.
5. *Motacilla flava* L.
6. *Motacilla citreola* Pallas
7. *Emberiza citrinella* L.
8. *Emberiza schoeniclus* (L.)
9. *Emberiza pallasi* Cabanis
10. *Emberiza leucocephalos* S. G. Gmelin
11. *Emberiza aureola* Pallas
12. *Alauda arvensis* L.
13. *Oenanthe isabellina* (Temminck
14. *Panurus biarmicus* (L.)
15. *Sylvia borin* Boddaert
16. *Saxicola torquata* (L.)
17. *Erithacus svecicus* (L.)
18. *Corvus corone* L.
19. *Anas crecca* L.
20. *Anas querquedula* L.
21. *Anas platyrhynchos* L.
22. *Anas strepera* L.
23. *Anas acuta* L.
24. *Anas penelope* L.
25. *Aythya fuligula* (L.)
26. *Aythya ferina* (L.)
27. *Anser anser* (L.)
28. *Tringa glareola* L.
29. *Phalaropus lobatus* (L.)
30. *Podiceps auritus* L.
31. *Sterna hirundo* L.
32. *Larus canus* L.

In the present case, mosquitoes are the most probable vectors for immunizing birds with virus. Positive results have been achieved in the virologic studies of mosquitoes carried out on a territory endemic with OHF and characterized by an abundance of lakes, as well as a wide zone of reed growth and marshes serving for the mass propagation of mosquitoes and the concentration of migrant waterfowl: eight strains of virus, identified as the virus of OHF, have been isolated from the mosquitoes *Mansonia richardii* Fic., *Aedes flavescens* and *A. excrucians*

(Netsky *et al.* 1966). Subsequently the virus of OHF has been repeatedly isolated from mosquitoes during two or three seasons in two different localities separated by a distance of 300-400 kilometres, but with similar landscape. It was also shown experimentally that mosquitoes (*M. richardii*) are capable of being infected with the virus of OHF on an infected white mouse, and of communicating the virus by stinging a healthy mouse (Volynets & Bogdanov 1971).

Mosquitoes in the forest-steppe foci of OHF can, therefore, be considered as the probable vector of virus to birds, since the role of ixodid ticks in the present case is excluded.

CONCLUSION

In West-Siberian foci of tick-borne encephalitis and Omsk hemorrhagic fever wide participation of birds has been established in the circulation of definite viruses. Involvement of birds in the circulation of viruses in the taiga and adjacent areas is connected with the regular feeding of ticks *Ixodes persulcatus* and *Haemaphysalis concinna* (latter in Altai) on birds. In the forest-steppes of Western Siberia birds are drawn into the circulation of these viruses without the ixodid ticks taking part, as the tick *Dermacentor pictus* practically does not attack birds. Mosquitoes are considered as the most probable carriers of viruses among birds.

The movement of birds assists in the formation of mixed ixodid fauna and of combined foci of infections connected with different species of ticks, which occurs owing to the carriage of ticks from biotopes where certain species of ticks predominate to adjacent territories where they are not otherwise found.

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Visual learning capacity and retention in the Tree Shrew (*Tupaia*): an extension[1]

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(*With three figures*—1 *in text*, 2 *inset*)

This paper is dedicated to India's foremost ornithologist, Dr Sálim Ali. Even if it does not dwell on birds we venture to offer it to him as a token on the occasion of his 75th birthday as he is also an eminent ecologist, general biologist and conservationist with a deep interest and love of animals: hence *Tupaia* may enter.

Since tree shrews (Tupaiidae) have been placed fairly high on the ascending evolutionary scale, and since some authors regard them as the link between Insectivora and Lemurioidea, or even as essentially lemuriform (e.g. Le Gros Clark 1934, 1959; Simpson 1945), every bit of information concerning their functional, sensory and behavioural performance is welcome as it might shed further light on the human whence and where of his own capacities. The problem of the systematic position of tree shrews is by no means settled as can be seen from the more recent papers by Van Valen (1965: tree shrews and primates not closely related, fossil evidence), Spatz (1967: contrary view, anatomical, histological, behavioural facts) and Martin (1968: behavioural evidence in favour of no close relationship).

To assess the visual learning capacity of an animal one has to rely on a method yielding quantitative results for comparison. Various parameters have been used for comparing animal performance and thus placing various animals on certain systematic and phyletic levels, e.g. learning speed, amount of errors in the learning process, duration of retaining the tasks learned, learning set, etc. The literature on animal learning and retention is vast, and we shall not go into details here.

One method which we used rather early and, as we hope, successfully is the serial rotation test of visual discrimination learning (Altevogt

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1951). In this method, the animal is required to learn a visual discrimination of two-dimensional patterns in a two-choice set-up, e.g. black cross versus black circle each on white background, and offered as a cardboard to be pushed aside to get the food reward. After the first two-pattern-discrimination has been learned to criterion, the animal learns the next task, say fine stripes versus broad stripes, again offered as black-white patterns on plaques. In this way a number of discrimination tasks can be learned one after the other, the data indicating learning speed, criterion reached, etc.

Serial rotation is introduced after two or more such tasks have been learned to criterion, i.e. then task 1, 2 and 3 are offered one after the other in this sequence or in any other predetermined order, say 3, 1, 2, 2, 3, 1, etc. Obviously, with increasing number of tasks learned, the number of stimulus pairs in each of such sequences increases, and the experimenter will find out just how many of the stimuli will be mastered quasi simultaneously by the animal as it is required to have the correct choices ready, e.g. to know the right (and wrong?) stimulus of pairs 1 to 5 if given the 5 pair serial rotation test. In this manner, especially Rensch and his collaborators have tested a number of animals of various levels from fish to elephants (survey given in Rensch 1962).

The range of visual learning capacity thus determined reaches from a meagre 1 in the opossum (Neumann, 1957) to 20 visually discriminated pairs of patterns in the Indian elephant (Rensch & Altevogt, 1955). Unfortunately, the monkey and ape level has not been touched yet as far as we know, and man himself has not been tested by this method either.

Tigges (1964) applied the method on tree shrews (*Tupaia glis* Diard 1820) ' since they belong to the most primitive level of primates....' (232). He used 3 pairs of black-white and 3 pairs of colour stimuli as discriminanda and found that ' none of the 6 animals was able to retain simultaneously more than 3 different tasks ' (240).

This rather poor performance does not compare favourably with the fact that a reasonably ' bright ' mouse or rat masters at least 5-6 pairs of visual discriminanda in the serial rotation test (Boxberger 1953; Reetz 1958).

While working on the behavioural physiology and ontogeny of *Tupaia glis* (Zeller 1971) we carried out a series of experiments on the visual learning capacity using the 6 pairs of black-white patterns shown in Figure 1. Thus we eliminated possible experimental errors most often inherent in studies using (pigment) colour stimuli (i.e. proper control of brightness and hue). The discriminanda were 6 × 9 cm in size and could comfortably be duplicated photographically. As they soiled rather often due to the animals' tendency to impregnate paths and objects of their home range olfactorily (for review see Zeller 1971) they were covered by plastic film so that they could easily be cleaned to control for possible olfactory clues in the discrimination trials. The discriminanda were offered on 2 – 4 small white doors of 10·5 × 10·5 cm which swung open if the animal touched them—which they did with their snout or hands. The experimental animals were given access to the discriminanda from a starting platform (bottom, Fig. 2) at a maximum distance of 50 cm from where they could view the discrimination pairs as shown in Fig. 3. Illumination by hidden bulbs resulted in a brightness level of 285 lux measured 18 cm in front of the discriminanda. After choosing the positive pattern, i.e. opening the respective door, the animal found the food reward (biscuit, lettuce, meat).

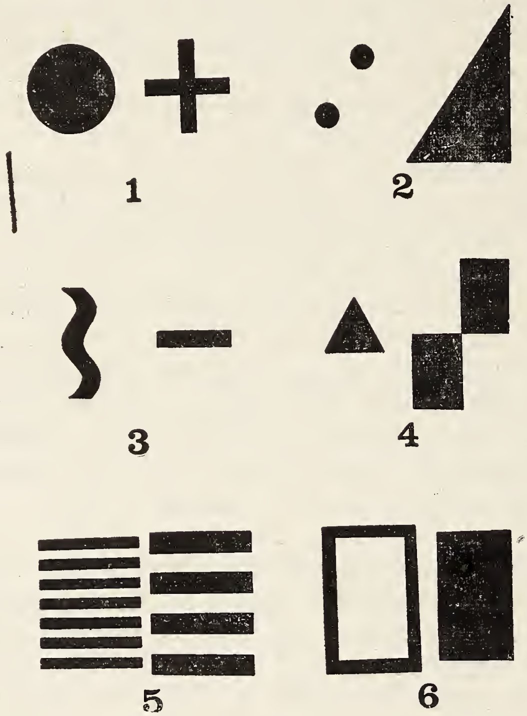


Fig. 1. The six pairs of discriminanda used in choice experiments with *Tupaia glis*.

To control for spontaneous preferences, the animals were first presented with both stimuli of each pair food-baited, and the pattern spontaneously preferred was given negative meaning, i.e. would not be rewarded subsequently.

For the daily trials the animal's living cage was connected to the choice apparatus by an alley, thus giving free access to the starting platform and keeping the animals' disturbance due to handling etc. at a minimum.

Experiments were run between 9 and 11 a.m. (sometimes to 1 p.m.), with food and water given ad lib. from afternoon to night. Normally there were 25 trials per day and animal.

The learning criterion was 5 consecutive days with at least 25 trials each and more than 75% correct runs per day (this is a higher criterion than that used by Tigges, who chose 72·1 % on 5 successive series following Koller's [1953] statistics).

All animals were housed individually in cages of 100 × 60 × 75 cm with a smaller sleeping and eating box of 20 × 20 × 17 cm. Room temperatures were 27 - 30°C and relative humidity was kept at 30 - 50%. Apparently this regime suited the tree shrews fine, as within 2 years the 7 animals we started with produced 19 young (for details see Zeller 1971).

From our animals we chose one ♀ and one ♂, both 1 year old at the beginning of the experiments, for the study of visual learning capacity. This small number would do as we only wanted to find out whether Tigges's findings could be extended or if indeed *Tupaia* must be credited with such a limited visual learning capacity as indicated in his paper.

Single tasks

Spontaneously the two animals showed the following preferences (Table 1):

Task No. ..	1		2		3		4		5		6	
♀ ..	9	11	—	20	17	3	9	11	7	13	6	14
♂ ..	8	12	7	13	10	10	8	12	10	10	10	10

Table 1. Figures indicate number of choices of respective pattern in 20 trials with both stimuli rewarded.

Correspondingly, if there was a strong preference of a particular pattern it was given negative meaning and vice versa.

Learning the discriminanda, offered as pairs indicated and in the order of Table 1, was mastered by both animals without difficulty except pair no. 3 ('snake' versus bar) which was learned by the male with a good record (80, 80, 88, 92, 88 %: average 85·6 % over 5 days with 25 trials each), but which could not be mastered by the female, who failed to reach criterion in 21 days. She was therefore offered another (i.e. 7th) pair of discriminanda : versus yielding 76, 80, 76, 84 and 76% correct choices, hence reaching criterion.

The respective correct choices by our test animals shown at the various visual tasks 1–6 are tabulated in Table 2.

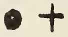
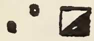
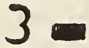
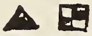
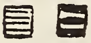
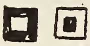
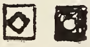
Task	♀%	♂%	Average % ♀	♂
	76, 80, 84, 84, 88	80, 84, 80, 84, 92	82·4	84
	84, 100, 100, 100, 100	88, 96, 84, 92, 88	89·6	98·8
	— — — — —	80, 80, 88, 92, 88	<75	85·6
	84, 80, 92, 80, 80	92, 96, 96, 96, 96	83·2	95·2
	— — — — —	76, 84, 88, 80, 80	<75	81·6
	96, 88, 88, 80, 88	80, 88, 80, 88, 76	88	82·5
	76, 80, 76, 84, 76	— — — — —	78·4	<75

Table 2. Correct choices (%) by *Tupaia*, in 5 series of 25 trials each leading to learning criterion.

Number of tasks

	2	3	4	5
♀	91·6	92·5	96·1	<75
♂	91·6	94·4	90·9	92·5

Table 3. Serial rotation test in *Tupaia*. Correct choices (%) in 2-, 3-, 4-, and 5-task test.

As can be seen from Table 3, both animals not only mastered the 3- and 4-task test in serial rotation with good results, but showed even better percentages of correct choices than in the single task tests. Thus, task 1 had yielded 82·4 and 84% in the single (see Table 2), but in the serial rotation of tasks 1 and 2 both the animals reached 91·6%. This finding is in accordance with data by Altevogt (1951) in chickens, by Rensch & Altevogt (1955) in the Indian elephant, and by various authors applying the same method on various animals (see Rensch 1962, for review). Possibly, the animal's attention and willingness to discriminate is aroused to a larger degree by the continuously changing order of discriminanda which may be less 'boring' than having to work on the same pair of patterns for a longer time.

Due to the fact that the female had not reached criterion in tasks 3 and 5, her 3-task test comprised pairs 1, 2, and 4, while in the male it was 1, 2, and 3. Both animals, however, scored excellently (♀ 92·5%; ♂ 94·4%).

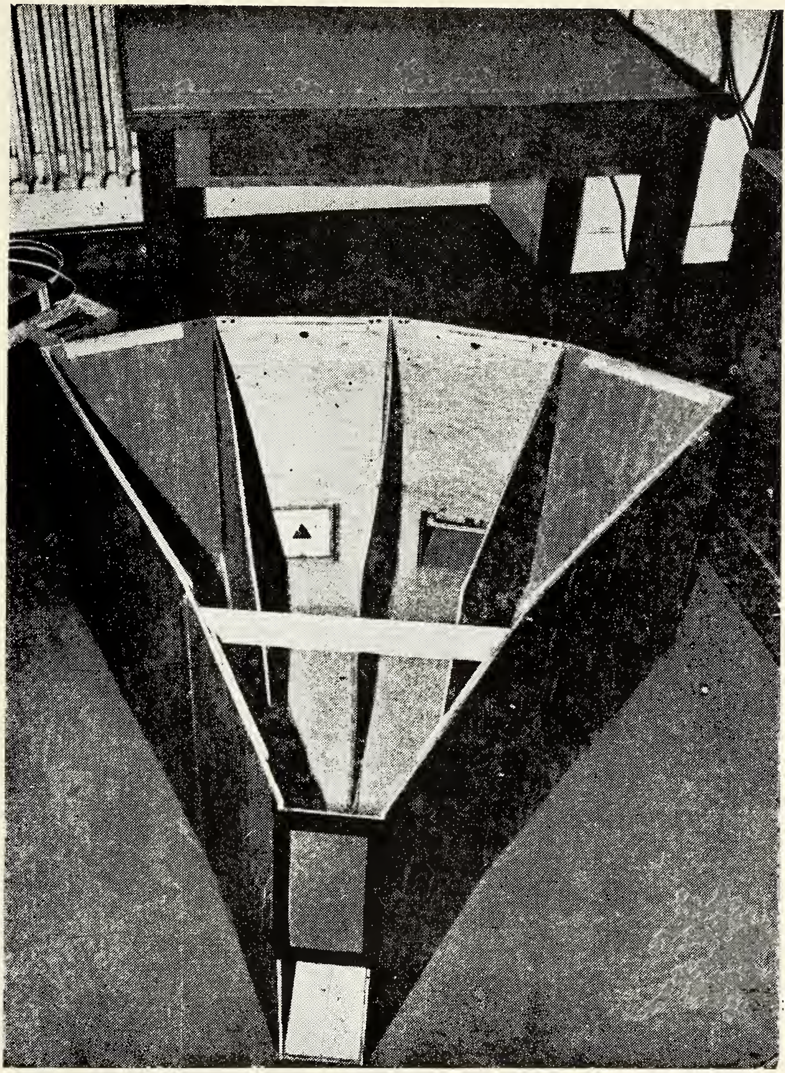


Fig. 2. Visual discrimination apparatus. Starting platform at bottom.

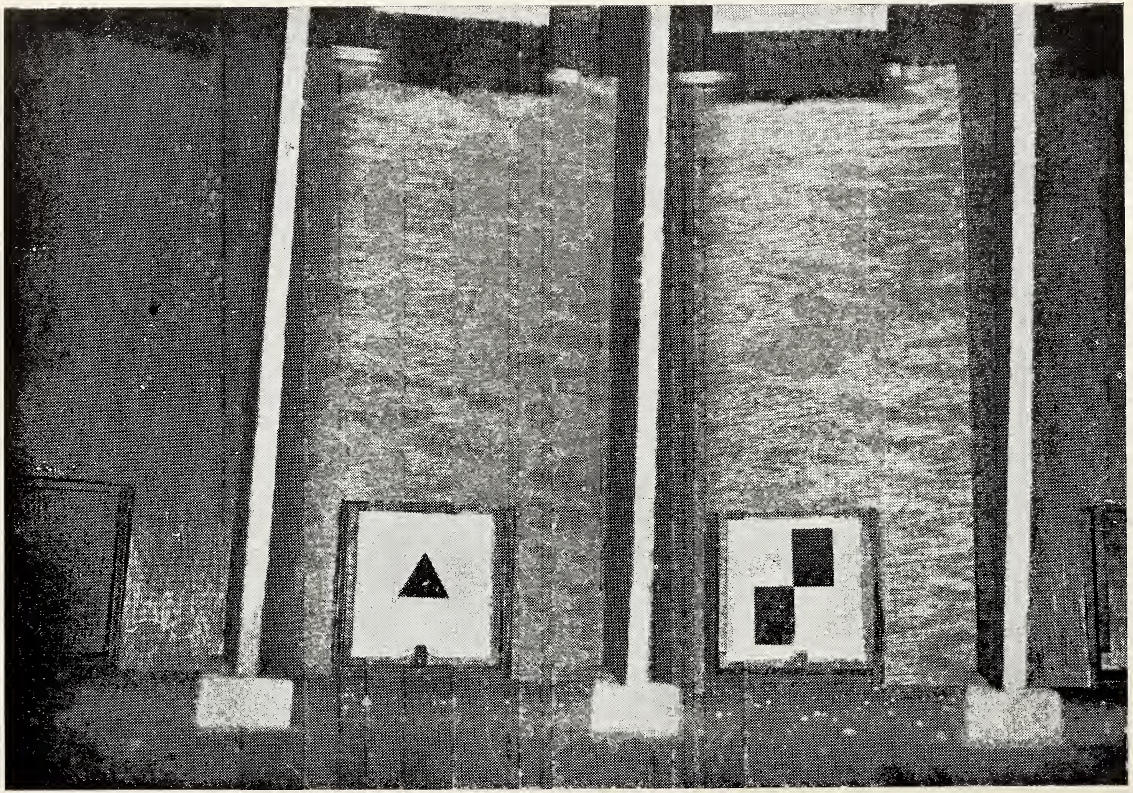


Fig. 3. A pair of discriminanda on swinging doors, animal's view.

Correspondingly, in the 4-task rotation the female was confronted with tasks 1, 2, 4 and 6, because she had not performed too well at task 5 (fine and coarse stripes). The male was given tasks 1, 2, 3, and 4, and reached an average of 90·9 %, while the female scored 96·1 %. Hence, both animals had already bettered the old *Tupaia*-record, and there seemed good hope of an even further improvement.

In the 5-task rotation the male mastered pairs 1-5 to a remarkable degree scoring an average of 92·5 %. The female (with tasks 1, 2, 4, 6 and 7) reached only 75, 72·5, and 67·5% on three consecutive days with 40 trials each, hence failing success. Repeated re-training at the apparently more difficult discriminanda did not improve the situation in the rotation presentation, hence indicating that apparently the visual capacity of this female was limited to keeping in mind 4 pairs of patterns at a given time simultaneously.

In the male this range could be extended to 5 pairs as shown by the 5-task test where he scored a surprising 92·5%.

Though the male learned task no. 6 (white versus black plaque) rather easily after this 5-task test, he was unable to perform the 6-task test, successfully scoring only 65·9, 53·7, and 48·8% on 3 successive days. Indeed, the behaviour of the male was now definitely changed as erratic bursts of locomotion, escape reactions and unwillingness to enter the discrimination situation etc. would impede proper and correct choosing. A similar behaviour was seen in the female leading to a failure already in the 5-task test.

Possibly, we might have succeeded in training our animals to an even higher level of simultaneously mastered pairs of discriminanda had we offered colour stimuli, as Tigges (1964) noted that ‘black-and-white patterns are obviously difficult for tree shrews to learn’ (242), and ‘that tasks involving coloured stimuli were learned rapidly and were well retained’ (235). For reasons of comparison, however, we did not try to do so, and we may state that in the ascending scale, *Tupaia* with at least 5 visual tasks mastered simultaneously fits in nicely as a reasonably good learner which possibly can do even better.

SUMMARY: Two tree shrews, *Tupaia glis*, 1 ♀ and 1 ♂, were trained in rewarded 2-choice tests requiring the visual discrimination of pairs of two-dimensional black-white patterns. After the first two pairs of discriminanda had been learned the animals were offered these pairs alternately in a serial rotation test which required the simultaneous mastering of the positive (and negative ?) stimuli of these two pairs. Similarly, after learning the 3rd, 4th, 5th, etc. pairs the 2-, 3-, 4-, 5-, rotation tests were offered.

The female mastered 4, and the male 5 tasks in the serial rotation test, and with this kind of multiple presentation both animals scored more correct choices than in most single-task learning.

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What leads to increases in the range of certain birds?[1]

Horace Alexander

Ornithologists have good reason to deplore the decrease and even the total disappearance of bird species in many parts of the world. The reasons for such decreases are no doubt various, but in all the continents and on many of the islands where birds are disappearing, the encroachment of that ever-increasing mammalian species, Man, is almost certainly the most important single cause. It may well be that Man's transformation of the environment is also the predominant cause in some, if not all, of the cases in which a species has noticeably increased.

Certain birds have become closely dependent on human artifice, whether using buildings for their nesting purposes, as with several species of swallow and martin (Hirundinidae) and swifts (Apodidae), or a more general use of human developments, as with the House Sparrow (*Passer domesticus*) or Starling (*Sturnus vulgaris*). In both sides of the North Atlantic, the Herring Gull (*Larus argentatus*) seems to have increased greatly in the course of this century, largely because the growth of modern cities has provided them with a new kind of reliable food in the form of large rubbish dumps. But in other cases, adaptation to man is not so recent, and one can only speculate as to the extent, if any, of increase of the species resulting from the (presumed) change in breeding habits. How many House Swifts (*Micropus affinis*) were there in India before man began to build solid houses? How many (or how few) Cliff Swallows (*Hirundo fluvicola*) before men began to build bridges of brick and stone across streams and rivers? Was the Common Swallow (*Hirundo rustica*) the common and very widespread species that it is today in the days when man was himself a scarce animal, living chiefly in caves? Today, all across its vast range, it seems to build its nest almost exclusively on man-made buildings.

Such questions are difficult to answer. It is better, perhaps, to concentrate on species whose increase is recent and certain, and for which it ought to be possible to assign some clear explanation.

Two species, both of them common and familiar birds in India, have greatly increased their range and so, presumably, their abundance in the world, during the past few decades. These are the Cattle Egret (*Bubulcus*

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[1] Received March 1972.

ibis) and the Collared Dove (Indian Ring-Dove of modern Indian bird-books, *Streptopelia decaocto*). It is my personal impression that increase or decrease of the range of a widely distributed bird normally reflects some change in its status in the centre of its range. So it may be worth while to examine these two spectacular increases with a view to enquire what, if any, circumstance in the environment in India (in the case of the Cattle Egret possibly the African environment is even more relevant) has led to the explosion.

The two cases are not really, I think, closely parallel, except at the ' receiving ' end. But each is worth examining.

It appears that the Cattle Egret found its way across the Atlantic to northern South America (Surinam about 1880 seems to be the earliest definite record) rather less than a hundred years ago. But it is only since it appeared in Florida in the 1940s that its increase has been spectacular. Now it breeds as far north as Ontario (Canada), and it has been recorded right across North America to the west coast. Moreover, the species has established a regular migratory habit in eastern North America, so that birds breeding in the mid-Atlantic States go south before the onset of winter. In February, 1971, I found it an astonishingly plentiful bird in Jamaica, though it was not recorded in the West Indies at all until 1952. Probably some of these were winter migrants from North America.

In the February 1972 issue of the magazine *Natural History* (Journal of the American Museum of Natural History, New York), William J. Weber discusses its breeding biology, which he has studied in order to see if there are special reasons why this species has increased so rapidly. He finds several such reasons. His summary is in these words : ' The nesting stability [i.e. he found that the adults returned to the nest very quickly after being disturbed, and quickly tolerated his presence], the incubating, brooding and feeding of the young by both parents, the dominant survival order of the chicks based on available food, and the long breeding season add up to an evolutionary balance favoring survival.' All this is of great interest, and shows reasons why the Cattle Egret should prosper ; but as none of these habits is known to be recent, it does not really answer the question : Why such a rapid increase in recent years ? Cattle Egrets are obviously among the species that depend on the presence of Man ; but it is Man the Herdsman, who is not a very modern invention, not Man the city-dweller or the industrial developer, whose activity is useful to them. Has there in fact been any noticeable change in the habits of Man the Herdsman in either Africa or Asia ? And has the Cattle Egret extended its range or increased in numbers in either India or tropical Africa ? The recent arrival of the species in Australia is, I believe, the result of introduction. Is there evidence of its increase in Southern Asia ? Or can it be that the spectacular increase in America is due first of all to a more or less fortuitous crossing of the Atlantic followed by the discovery of a 'niche' in at least Central and North America which was open to it, and which it has rapidly filled? As far as I can see there has been no noticeable spread of its range in south Europe.

The spread of *Streptopelia decaocto* is quite another matter, though here too we may end by asking questions for which, as far as I can judge, there are no very clear answers.

First, let us try to see what the story is: A century ago, when H. E. Dresser was writing his great BIRDS OF EUROPE, the 'Collared Turtle-Dove', as he called it, was only found in the extreme south-east of Europe, in the Balkan peninsula. It is interesting to note that, even in those days, in that part of its range, it preferred to live in or around towns and villages. Thus, Dresser quotes Messrs Elwes and Buckley as writing (in *The Ibis* for 1870) that 'it inhabits most of the towns and villages in the south of Turkey.... In Constantinople it is especially numerous, and also in some of the Macedonian villages which are interspersed with trees and gardens. It appears to love the neighbourhood of dwellings, and may be seen sitting, like a Sparrow, on the roofs of the houses, where it is never molested by the Turks'. So its behaviour in Turkey a hundred years ago was the same as its behaviour in western Europe in the 1960s.

In India, which I am treating as its original home, this close identification with the haunts of man is not so obvious. Here let me quote the latest and fullest account in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, by Sálim Ali and Dillon Ripley, vol. 3, p. 148, published in 1969: 'One of our commonest doves; very plentiful in some areas, inexplicably scarce in others outwardly just as suitable. Keeps in pairs or small Parties—often in company with other doves—gleaning in paddy stubbles, newly sown millet fields, or fallow land often in the environs of towns and villages. The birds perch freely on the buildings, and boldly enter cattle sheds and verandas and courtyards of rustic dwellings to feed within an arm's length of the occupants.' Local migrations are noted.

Let me add a paragraph about the habits of this bird as I have noted them in Britain since it arrived there and bred in Norfolk in 1955. Then we can see whether the available information gives any clue to its quite extraordinary 'explosion' during the past forty years.

The Norfolk colony, which I watched more than once, fed in the grounds of a good-sized house, near the sea, and the birds nested in cypress trees, which are, of course, not native to England. For some years this addiction to cypress trees was noted as a characteristic feature of most of the early colonies in the south of England. I doubt if that could still hold today, when the species has become so widespread that it is nesting in deciduous trees quite commonly. Indeed, the first pair that were known to breed in Kent (SE. England) were nesting in a deciduous tree at a farm quite a long way from the sea. But, like the Norfolk birds, these Kentish doves were able to feed on the food provided for fowls ; and this would be true for many of their early colonies, indeed it is probably true over most of the British range. Before leaving south-east England, I may recall that in October, 1959, only four years after the first Norfolk birds had nested, and only two years after the first Kent birds had been shown me (very secretly), we spent a few days at the small town of Lydd, a few miles from the English Channel. It is a town I have known all my life, and I have known just what birds to expect there. But this was different. The one large grove of trees was constantly alive with the 'coo-coo-cuk' of Collared Doves. Already the local inhabitants were beginning to get tired of their perpetual cooing. We saw a dozen or more together. They were well established.

That is only thirteen years ago. The latest British Ornithologists' Union British bird list (*The Status of Birds in Britain and Ireland*), published in 1971, summarizes the present status of the species in Britain thus : 'It now breeds locally in all except a very few counties in England, Wales and Scotland, and in at least half those in Ireland.' The emphasis, perhaps, is on that word 'locally'. One of the peculiarities of its spread, both on the continent of Europe, and in the British Islands, is that it has advanced, not along a steady, broad front, but by a series of leaps. Often it has jumped across some seemingly suitable areas, but in course of time it may fill them up. Thus, the city and county of Oxford, which is singularly well supplied with bird-watchers, was missed out for several years, while the doves were colonizing all around. Dr Radford, when she published her book on the BIRDS OF BERKSHIRE AND OXFORDSHIRE in 1966, gave no records for Oxford city. On the other hand, those who were with the famous International Congress voyage all round Scotland in July 1966 will recall that we found Collared Doves cooing on the roofs of the houses in Lerwick, Shetland, the most northerly town in the British Islands—just north of latitude 60°. This seems a strange place of permanent residence for a species whose headquarters are in the tropics. The same might, no doubt, be said of the House Sparrow, only that its wide distribution is something we are accustomed to. Yet it does seem to underline the fact that Collared Doves, like Sparrows, evidently depend for their success on Man, not on a limited natural environment,

Do these facts give us any clue to the spectacular increase of the Collared Dove in recent years ? I am not sure that they do. When did the north-westward spread begin ? Have they lived in the Balkan peninsula for centuries ? Or was their presence in 1870 due to quite recent colonization ? The spread of the species across Europe in the second quarter of this century has been very fully described by James Fisher in a characteristic article in *British Birds* (Vol. 46, Number 5, May, 1953). With regard to the early history, Fisher writes : 'The researches of Adametz and Stresemann (1948) and Stresemann (1950) have shown that it is unlikely that the Collared Turtle Dove had spread west to the Levant before the sixteenth century,' though there is some evidence that it inhabited Persia at that time. 'Stresemann is satisfied that *Streptopelia decaocto* was, by 1547, already one of the birds of the town of Constantinople.'

Curiously, in spite of the immense bibliography appended to Fisher's article, it seems that he did not consult the various mid-nineteenth century authors quoted by Dresser. But the position at the beginning of the twentieth century seems to have been about the same as it was in 1870. It looks as if there had been a spread from India several centuries ago; then a long pause, covering centuries, and finally a thousand miles and more of northwestward spread in the past forty years. This spread is given in great detail by Fisher, who wrote just before the first definite colonization of Britain. In 1954, when the well-known FIELD-GUIDE TO THE BIRDS OF BRITAIN AND EUROPE was first published, the Collared Dove is shown as resident throughout Denmark and even in south Sweden, but it had not yet crossed the North Sea.

What one would like to know, but it may be impossible to discover, is what change, if any, in the environment in the basic habitat of the species, that is to say in India or possibly West Asia, took place in the period just before 1930, to which the Collared Dove (Indian Ring Dove) responded; or, alternatively, what significant change in the habits of the species took place about that time? — such as a change in feeding habits or in adaptation to a changing environment. In India it was certainly a time when the human population was increasing rapidly. Was it also a time when the human inhabitants of India, especially the villagers, adopted new methods of storing grain or of growing crops that might be of advantage to such a bird?

Fisher quotes Dr Ernst Mayr as saying (1951) 'in all cases of explosive range expansion such as have occurred in the Serin (*Serinus canarius*) ... and in the Ring Dove (*Streptopelia decaocto*), there is reason to believe that this expansion was initiated by a genetic alteration of the peripheral populations'. I hesitate to question such an authority as Mayr; but Fisher himself does not believe that this applies to the Fulmar (*Fulmarus glacialis*), a species whose spectacular increase in the twentieth century Fisher himself investigated very thoroughly, demonstrating that it seemed to be closely related to a change in the habits of fishermen; so, it would seem to me at least possible that there is another explanation in the case of a species as closely dependent on Man, who is constantly changing the environment in drastic fashion, as the Collared Dove appears to be.

There are other questions that arise in one's mind. Has there been any visible increase in the population of *Streptopelia decaocto* in India itself? or in Persia, where a hundred years ago, according to authorities quoted by Dresser, it was scarce? Is there any sign of an extension of range in other directions? Fisher was not able to show any when he wrote in 1953, but perhaps that is not quite conclusive. There may be other questions we should be asking. I wonder if any of them are answerable.

Let me summarize: It is clear that *decaocto* has some of the characteristics of a 'successful' bird of this era in the world's history. It has adapted itself to Man and some of the changes he has made in the environment. It has a broad range of food. In some parts of its range, it breeds at all times of the year. But these things do not explain why it has suddenly colonized more than a thousand miles of fresh territory in the past forty years. If these are old characters, one would have expected the species to have spread over a large area much longer ago. So, one looks for some dramatic change either in the environment or in the adaptability of the species. Neither of these is obvious; so one is tempted to accept Mayr's proposition of a 'genetic alteration'; but how can that be proved?

It will be seen that the purpose of this essay is to ask questions, rather than to explore or expose work already done. I have little doubt that there may be very diverse explanations for the expansion of the range of different species. Let me conclude with an example taken from India, which looks to be quite unlike the examples I have been examining—a case where it is difficult to see that the expansion of range can be due to Man's influence on the environment.

When I spent a few weeks in India, chiefly in and near Delhi, in the late part of 1971, I was amazed to see Pied Mynas (*Sturnopastor contra*) at many places. Twenty years ago we thought them uncommon round Delhi. From what I have seen of it, I do not think the species has adapted to human modifications of the environment. Of course, many species have their rises and falls, over, perhaps, a fifty-year period. If in fact the Pied Myna has increased in recent years, it may be a case of this sort.

Perhaps there are other cases of birds that have made notable increases in range or in numbers in India. The purpose of this essay is to invite closer attention to such phenomena, so that, if at all possible, we can learn something of their hidden causes. From my long and happy association with Sálim Ali, in field and home, I suspect that it is the sort of enquiry he would welcome and encourage.

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Dr Salim Ali and I[1]

Yoshimaro Yamashina

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I first heard the name of Dr Sálim Ali in 1933. In those days, I had a great interest in the birds of Formosa and had dispatched a collector and research worker there, who stayed continuously for five years on the Island. I myself also made several trips to Formosa to make personal field studies on classification, distribution and habitat of the birds of Formosa (Taiwan). I noticed that the birds of lowland Formosa were exactly similar to those of mainland China, but that the birds of the mountains bore a striking resemblance to the birds of the Himalayan Range and Northern India.

As a result I began to study the literature of the birds of Northern India and was amazed to find the name of only one Asian ornithologist, Dr Sálim Ali, among many notable names of the western world. The name of that sole Indian bird expert, Dr Sálim Ali, has been carved deep in my heart ever since.

My first meeting with Dr Sálim Ali in person occurred in 1958 at Helsinki, Finland, where the quadrennial Conferences of IOC and ICBP were held. It was my first experience of visiting Europe, and as it was right after the termination of World War II, I was bewildered by the confused state of post-war Europe and, naturally, I could not enjoy the trip on that occasion. However, I was able to accomplish my object somehow or other, mainly because I fortunately had the delightful privilege of being warmly greeted by noted ornithologists such as Dr Delacour and several others with whom I had been exchanging communications for more than twenty years in the past.

At the Helsinki Conference Dr Sálim Ali seemed quite familiar with European affairs and accustomed to the proceedings of international meetings from past experience. This made me most happy and I felt at ease under the able guidance of Dr Sálim Ali in many ways during the conference. His warm cordialness is one of the sweet memories which will remain with me to the end of my life.

Two years after the Helsinki gathering, Dr Sálim Ali came to Tokyo to take part in the ICBP conference in 1960. His amiable personality and charming good humour were chiefly responsible in bringing success to this international assembly, the first held in Asia.

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[1] Received February 1972.

After the conference was adjourned, a field trip was made to Hokkaido which has been considered as the most remote region in Japan. Having few facilities to receive foreigners, I and my associates had been feeling somewhat uneasy for our guests in case of any inconvenience or breach of etiquette. Wherever Dr Sálim Ali appeared however he always provoked cheerful laughter, making that side trip to the northland a most delightful and fruitful event.

At this 1960 Tokyo meeting, the Asian Continental Section of ICBP was initiated and Dr Sálim Ali, as its Vice-Chairman, has done a great deal to enable this newly established Section to grow as it has today. He has been highly admired by all the members of the Asian Section. He is not only the respected elder scientist of all Asia, but has been an active adviser as well as a dependable counsellor from the beginning. It is worth mentioning that the successful outcome of the Hong Kong meeting of the Asian Section and the subsequent conference in Bharatpur, India, were chiefly due to the tireless efforts of Dr Sálim Ali.

On this memorable occasion, celebrating the 75th anniversary of the birthday of our dear friend, Sálim Ali, I sincerely wish to extend heartfelt congratulations, as one of his fellow bird-lovers of the Asian Section, and respectfully hope that Dr Sálim Ali will keep up his usual vigorous spirit for a long future and continue to guide our deliberations with his agreeable presence.

A portrait of Salim Ali

ZAFAR FUTEHALLY

My first real contact with Sálim Ali the ornithologist, as opposed to Sálim Ali the uncle by marriage, was when my wife and I visited his bird camp in Palanpur State, Saurashtra, in 1944. He had invited my wife to come to Palanpur, and she had taken the precaution of misunderstanding the invitation to include me.

We arrived at Palanpur expecting a holiday atmosphere in the beautiful lodge at Balaram overlooking a broad nullah with thick jungle beyond. I found that all the members of the camp, which included two skinners and an unlimited number of 'orderlies' of the Raj, were driven much harder by Sálim than any slave-driver would have dared to drive them. The team left the bungalow in the small hours with their collecting guns. The middle of the day was taken up in weighing, measuring, and skinning the morning 'bag'. Another round in the jungle in the evening with notes being written up late into the night. As I got to know Sálim better, I discovered that an untiring thoroughness was part of his nature and what he expected from others was only what he demanded of himself. He can also work longer hours than anyone else I know. Whenever we stayed with my wife's parents, I got used to hearing his typewriter tapping at 5 o'clock in the morning. This usually continued late into the night, with short intervals for meals, and a walk in the evening. The sight of the slight but muscular figure in shorts, carrying a stick, must have become familiar in the neighbourhood.

Except partly for the HANDBOOK, the material for all his books has been collected, researched, written and typed by himself. Two volumes of the HANDBOOK had already been completed in this same solo fashion before it was decided that the Bombay Natural History Society would offer him the services of an editorial assistant.

The perfectionism which he had developed in his ornithological work extended to everything connected with his life. Each field trip was planned, mounted, and carried through with exactness. He personally worked out the logistics of every expedition; personally supervised the packing and loading of all the gear; and personally checked the condition of every part of the car. His own physical fitness and the fact that, all his life, he has been hardier than any young man half his age, has great advantages of course. When he was well over 60, I have seen him pulling himself on to the back of a standing camel while the rest of us were looking round for ladders.

The camp at Palanpur was the tail end of the Gujarat Bird Survey. These bird surveys were, in a sense, invented by Sálim himself in the early thirties, when he had no other employment. With the help of S. H. Prater, the then Curator of the Bombay Natural History Society, it was arranged that he should make a survey of the birds of the Nizam's State of Hyderabad. The Bombay Natural History Society would provide the skinners and assistants. The Nizam's Government was persuaded to contribute Rs. 3,000 towards the cost of keeping the expedition in the field for four months. The skins would be sent to Hugh Whistler in England for taxonomic study, and the final report would be published jointly in the *Journal* of the Bombay Natural History Society. Although it was obvious that such a survey would not make Sálim a rich man, he found that the undertaking was extraordinarily rewarding. He was simultaneously pursuing a hobby, gaining invaluable knowledge, and living among surroundings, and in a manner, which he most enjoyed. Even more important, perhaps, in a manner which his wife also immensely enjoyed. Indeed, it would have been difficult to undertake these surveys without her enthusiasm and help.

Between 1934 and 1948, Sálim did bird surveys of any area where the administration was willing to bear a part of the cost. He 'did' the Indian States of Travancore, Cochin, Bhopal, Indore, Gwalior and Dhar, Mysore, Bahawalpur, Gujarat and Bastar. With these surveys, plus several years' residence in Burma and innumerable other trips, it is now difficult to put one's finger on any part of the map of the Indian subregion which Sálim has not penetrated on an ornithological quest at some time or other. It used to be said that there was no part of India where Nehru had not been. I am sure that this remark would be even truer of Sálim.

Since my first visit to the bird camp at Palanpur, I have invited myself to as many camps as possible, although it has had to be for short periods for I have to earn my living at a 9 to 5 job. An especially interesting period began in 1959 when Sálim was asked by the World Health Organization to undertake migration studies, in order to discover whether ticks carried by migratory birds could be the carriers of viruses, with special reference to a 'new' one that had erupted in Mysore. I attached myself to one of the first sorties which was going to Kutch, whose sandy, salty wetlands were known to be visited by countless migrants on their spring and autumn routes. Consequently, camp was pitched in a place called Kuar Bet—well known, it so happened, as an area abundant in the Saw-scaled Viper. Our first evening in camp was devoted to trying to understand how to use the anti-venom snake kit which Sálim had, with his usual foresight, brought along. After struggling with the instructions contained in the kit, it was generally agreed that, in case of a bite, the victim should quietly be allowed to die. This was also the first time we were using mist nets and the greater part of the day seemed to be spent in struggling with the strange and unmanageable nets. Incidentally Loke Wan Tho was present at this camp for a few days and his unfailing cheerfulness and enthusiasm enlivened everyone.

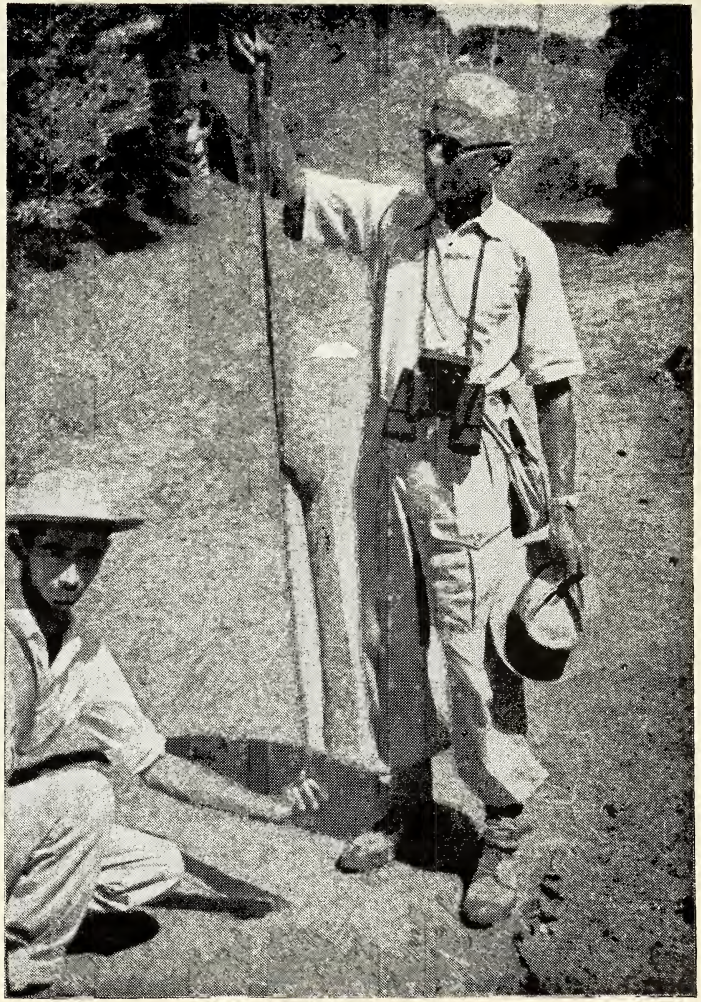
As the Bird Migration Scheme got under way, there were camps at Bharatpur, Edanad, Point Calimere, Rajkot, Daulatabad, Mahableshwar, etc., etc. These camps became meeting-places for all kinds of naturalists, ornithologists, scientists, professionals and amateurs, locals and foreigners. Anyone who could manage it would take a few days off to join the camp, and lend a hand with the netting and banding. Here one met new people with shared interests, and renewed friendships with old cronies. Young people, the children of friends and relations, also appeared whenever their school or college holidays allowed them to. Sálim has always had a special rapport with children, from babies onwards. His humour seems to be at its liveliest in their company. And if any child showed the slightest interest in natural history, he would lavish on it an enormous amount of time and trouble, teaching him or her and helping to build up their interest. Considering that he has a naturally impatient temper, it always amazed one that he was so patient with children. In the old days it was nephews and nieces who trailed around with him ; later on it was grand-nephews and grand-nieces ; while today he still has a large following of great-grand-nephews and great-grand-nieces. It is to be seen whether any of these turn out to be a worthy successor. At the same time, Sálim's influence has been pervasive in our family and I think that there is greater interest in nature generally and birdlife in particular among the members of our family than there is in most comparable groups.

If Sálim took so much trouble in encouraging amateur interest, he exerted himself even more to help serious students and young professionals. Sometimes, indeed, the time and trouble he expended on helping young naturalists with their work seemed almost disproportionate. Anyone who wished to make a career in Sálim's favourite subject could count on every possible kind of help and support from him. My own interest in birdlife and in conservation stems largely from his encouragement, although he has never, even by accident, allowed me to realize that he knows this. The kind of hidden jealousies and envies which sometimes attack even the most eminent scientists in their dealings with their juniors seem never to have touched him. My amateur entry into the world of birds has a curious history. The *Times of India* in the early fifties once carried an article on the Magpie. The author had obviously never seen our Magpie-Robin nor the European Magpie in the field and from such sources as he could lay his hands on in the library, produced a concoction which implied that the Indian bird (*Copsychus saularis*) had many of the characteristics of its semi-namesake in Europe. Sálim wrote an irate letter to the Editor which immediately fetched the expected response of asking him to produce an article. Not having the time to do so, Sálim passed on this assignment to me and this led me to take a greater interest in avians than I would otherwise have done.

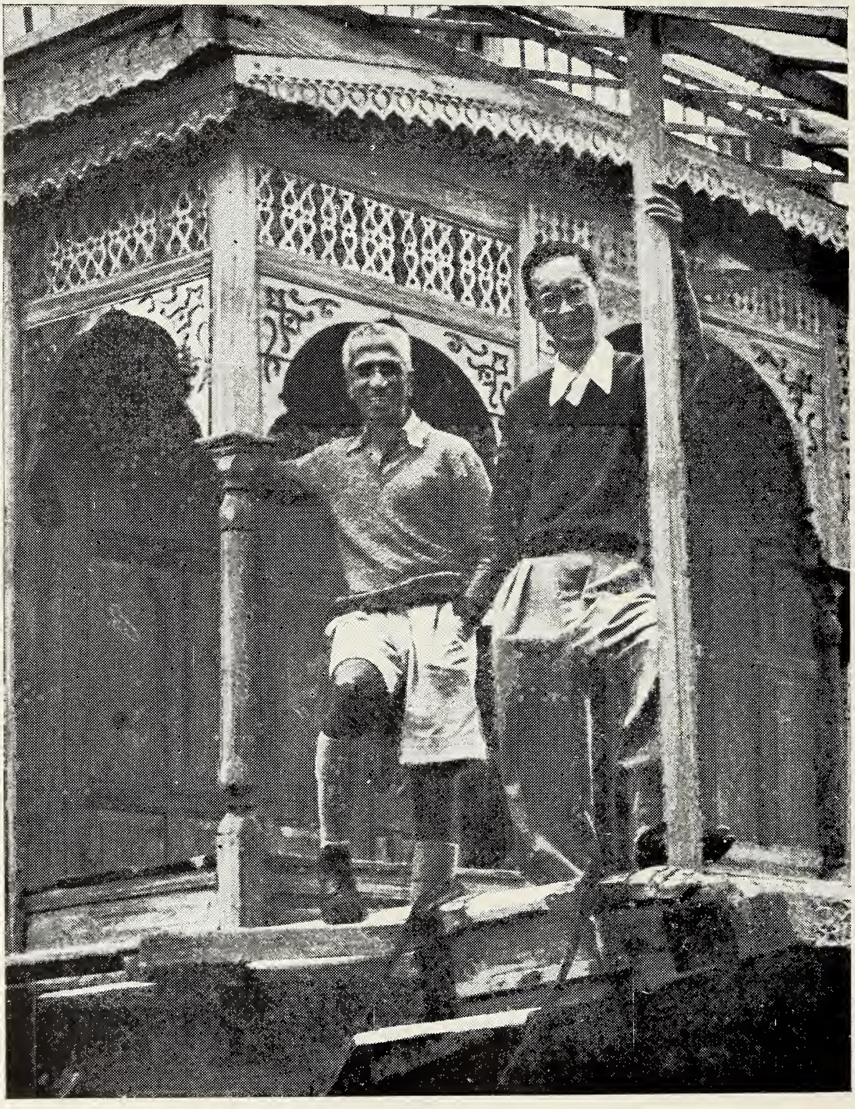
On many occasions while accompanying Sálim on bird-watching trips I have felt that he has been over-conservative in coming to conclusions and never being content with circumstantial evidence, however convincing it seemed to be. Not being of a particularly scientific bent of mind myself, and more prone to generalizations than to detailed inquiries, I often found his comments frustrating. But at an outing in Bhutan, I recognized that one can never be too cautious in dealing with birds and their identification in the field. We came across a group of Longtailed Sibias (*Heterophasia picoides*) with white foreheads. Sálim expressed his surprise at this because he said that this species was not supposed to have any white anywhere except on the wing. I had expected him to be more enthusiastic about having discovered a new species or at least a new race, but he said dryly that one could never be too sure until one had a bird in hand. The white on the forehead was so obvious, and the reference books which we consulted on returning to camp so explicit about the lack of any white on the head of these birds, that I thought this was truly a case of disregarding the time-honoured principle that seeing is believing. However, the next day when Sálim was out with his collecting gun he came across these sibias and shot one of them. It turned out that the white colouring of the forehead was caused by the pollen of flowers on which the birds had been feeding. Since then I have acquired a new respect for the adage that a bird in hand is worth several in the bush.

I have referred to Loke earlier, and it was in the camp at Kutch that I got to know him really well. Wan Tho Loke was soon to make a name as one of the best bird photographers in the world. Loke, a Malayan, was an evacuee in Bombay during the war years. Being interested in bird photography, he fell into the habit of becoming part of any expedition which Sálim planned. Loke had a remarkable capacity for taking immense pains, for making light of hardships and irritations. His easy amusingness blended well with Sálim's more cynical wit, and he was always a wonderful companion as well as a dependable helper. Once in Madhya Pradesh during World War II while he was pushing the broken-down old charcoal-driven bus uphill, he suddenly said, 'You really ought to have a station wagon, Sálim.' And when he got back to Singapore after the war, and found himself once more a millionaire, he sent Sálim a station wagon.

Indeed, once Loke was back in Singapore it seemed that Sálim's financial problems were solved for always. Whether it was a question of mounting an expedition, buying technical equipment or attending a meeting on the other side of the world, Loke always insisted on having



Above: On the Lipu Lekh, *c.* 5000 m, en route to Tibet, June 1945.
Right: Measuring a baya nest, *c.* 190 cm with his student
V. C. Ambedkar, Poona, 1958.



Sálim Ali and Loke Wan Tho on the houseboat *Pandora*, Kashmir, 1951.

the honour of providing the means. It may be added here, as an aside, that after his tragic death in 1964, his family have kept up the tradition.

I once asked Sálim which single event in his life had given him the greatest pleasure. I thought it might be the completion of the great 10-volume HANDBOOK of Indian Birds, to which he was then in the process of putting the finishing touches ; or some of the many distinctions and honours which had been showered on him by various institutions or possibly the Padma Bhushan which his own Government had bestowed on him. The occasion in 1969 when he was given the John C. Phillips medal for Conservation, and the whole vast assembly of the I.U.C.N. rose to give him a standing ovation, could easily have been the most satisfying event in anyone's life, however great. But his answer was unexpected. It was his work on the breeding habits of the weaver birds, he said.

His paper on the weaver bird is, of course, a classic field study, enough to ensure immortality for any ornithologist. It was written at one of the most anxious periods of his life. When he returned to the Bombay Natural History Society after a study leave of eight months, he was told that his post had been abolished. No one in India those days—not that things are very different today—employed a naturalist; certainly not one without a university degree. All efforts to find employment having failed, he and his wife removed to a family house near the sea coast simply because it was the cheapest place to live. And it was there, half a mile from the house, that Sálim found the bayas building their colony and studied them to such good effect. Perhaps, on second thoughts, it is not really strange that he should consider the baya study so rewarding. Ornithology often involves long processes of recording, checking, collecting and comparing material. It is seldom that one has the chance of original work, the discovering and registering of such unlikely processes as the nesting habits of the bayas, which can be truly classed as a piece of creative work. For a naturalist like Sálim, always much more interested in field work, in the living bird rather than the dead skin, such observations represented the most deeply satisfying facet of his vocation. He was really an ecologist even at a time when the hard core of ornithology was still considered to be systematics.

The baya study then, was the silver lining to the cloud of his self-imposed exile. I might add here that he often admits that his inability to find a job, ' in spite of his best efforts ', was one of the luckiest things that ever happened to him. Imprisoned behind a bureaucrat's desk, his life would have been much less productive. And, of course, much less fun.

Throughout his life, I have heard Sálim make grateful reference to Dr E. Stresemann, whom he refers to as ' my guru '. The face-to-face contact with the guru lasted exactly seven months, when Sálim studied systematics with him in 1929 in Berlin. For the next almost half-century, contact was kept up by a copious correspondence. Dr Stresemann apparently wrote a very difficult hand, as opposed to Sálim's exquisite writing (of which he is very proud). Nevertheless the contact with Dr Stresemann was like a lifeline, to be used when in doubt. He wrote careful advice, suggestions, instructions, encouragement about everything—from the correct way to pack skins to ideas for new ecological studies. For, very soon, Sálim was writing to say that he was finding field studies far more exciting than laboratory work among specimens. A theme which was often discussed was the idea of research into the interrelation of birds and plants. Nobody had attempted to analyse the part played by birds in propagating or in destroying the vegetation around them. Surely this was odd in a primarily agricultural country where so much depended on conditions which govern the success or otherwise of crops? Stresemann suggested making germinating experiments with fruit-stones taken from faeces of birds and stones of some fruits which had not been swallowed by birds. 'Nothing seems to be known from India regarding biological and field questions of the transfer of worm parasites to birds.... ' Some of the ideas churned up in this correspondence form the basis of Sálim's repeated attempts to persuade the Government of India to finance a major research project on the role of birds in agriculture. There seems hardly any need to emphasize that, in our country, such a project would indeed be money well spent.

As could be expected from their common interest, one of the close associates of Sálim Ali from about 1933 until his death in 1948 was Hugh Whistler. Whistler was very excited when Sálim started his territorial surveys commencing with Hyderabad in 1933 for he felt that it would be a great thing to get the huge blanks on the map of distributions filled in for Hyderabad and other places. Obviously Sálim's comments and guidance were of great help to Whistler and he acknowledges this generously in a letter dated 24 October 1938. 'It has been a very great benefit to me that we drifted into collaboration largely in its beginning as an accident—when you pointed out my mistake over the webs of Drongo's tail feather—and the mistake has proved to me well worth while. And here and now I must thank you very warmly for making my collaboration a condition of your undertaking the Mysore and Sunderbans surveys.'

It was Whistler who put Sálim in touch with Col. R. Meinertzhagen, whom he joined in a collecting expedition to Afghanistan. Col. Meinertzhagen was a colourful and controversial figure from whose very original methods of field work Sálim gratefully acknowledges that he learnt a great deal. The relationship began stormily enough; neither of them had any extra stock of forbearance. But they soon began to trust each other, and to plan and undertake other joint expeditions, and long before the end of his life, Meinertzhagen had become one of Sálim's most reliable friends. There are, indeed, hardly any professional colleagues with whom Sálim has not managed to make lasting friendships. Friendships have a very important place in his life.

There was something particularly tragic in the death of Sálim's wife in 1939. She had encouraged him to pursue his hobby rather than attempt to enter some uncongenial profession. She had preferred to live on her own small income rather than press him to find a job ; she had created conditions in which he could work uninhibitedly at his own special interests. And she died a few months before his first taste of real success, the publication of THE BOOK OF INDIAN BIRDS. After his wife's death Sálim moved away from Dehra Dun and made his home with his sister and brother-in-law in Bombay, the parents of my wife. I think he would agree with me that, to the extent they could, they have created for him conditions in which he could continue to work effectively. This sort of tacit support has always been provided by all his numerous brothers and sisters at various crises of his life.

THE BOOK OF INDIAN BIRDS had been a long-planned Bombay Natural History Society's project, to be based on the sale of wall charts of bird pictures. The same blocks were to be used in the book. From the moment it appeared, it was clear that the book ' filled a strongly-felt need ', although a great part of its success was certainly due to the attractive style of writing. Now in its 9th edition, much enlarged and continuously brought up to date, the book remains the standard guide-reference book for the Indian subcontinent, and is perhaps the only book which is bought by novices as well as experienced ornithologists. One of my friends possessed a copy which he had found abandoned in a prisoner-of-war camp in Indonesia. It had helped him to become an ornithologist during the war, and he managed to get it autographed when he came to India 30 years later ; another copy was given by Nehru to his daughter as a birthday present at the time he was prisoner in Dehra Dun jail.

In 1942 the Oxford University Press agreed to publish INDIAN HILL BIRDS, and seven years later it appeared, superlatively well illustrated by G. M. Henry. THE BIRDS OF KUTCH had already been issued, and THE BIRDS OF TRAVANCORE AND COCHIN followed in 1953 and THE BIRDS OF SIKKIM in 1962. And finally the magnum opus which is, of course, the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, whose tenth and final volume was delivered to the Press some months ago.

As far back as 1947 Stuart Baker's volumes on Birds in the FAUNA OF BRITISH INDIA series were already out of date, and it was obvious that, instead of reprinting, the Government of India would be better advised to commission a new work altogether. In fact, in 1947, Sálim, once more in touch with his mentor Stresemann after the war, told him that he had submitted a memorandum to the Government, detailing the lines on which the new book should be produced. He would like to have it more or less on the lines of Witherby's HANDBOOK OF BRITISH BIRDS with suitable modifications. It should have as many species as possible—not subspecies—illustrated in colour—their distribution being shown on maps. At the time Sálim was in the Mishmi Hills with Dillon Ripley, and they talked of the possibility of collaborating on the project. Their ideas agreed on many points. Both thought that splitting the genera, species and subspecies had been carried to meaningless lengths, and a halt must be called. Mayr and Delacour's recent review of the Anatidae was the line systematics should be modelled on. It seemed a suitable arrangement that Ripley should be responsible for the systematic arrangement of the work, while Sálim looked after the field notes and habits. With support from the Government of India, the Smithsonian Institution and the Bombay Natural History Society, the Oxford University Press was able to undertake publication of this major work.

At 75 Sálim Ali is far from being a spent force. He is working hard on a new book, and only the King's death prevented him from visiting the ornithologically unexplored parts of northern Bhutan this year. Even as the final pages of the HANDBOOK are leaving for the press he is well on his way to completing a FIELD GUIDE TO THE BIRDS OF THE EASTERN HIMALAYAS. He also plans to survey the former Portuguese territory of Goa. It is certain that his passionate dedication to Indian ornithology will make it impossible for him to retire or to cease to study birds.

Reviews

1. SEVENTY YEARS OF BIRDWATCHING. By H. G. Alexander. pp. 264 (21·5 × 14 cm). With drawings by Robert Gillmor. 15 photographs and six maps. Berkhamsted, 1974. T. & A. D. Poyser. Price £ 3·80.

'I have always enjoyed keeping records of what I see.' And what records! Until his ears began to give way, in his late sixties, Horace Alexander recorded every bird song he heard every day in the year, at any rate when he was in Europe. In this book there is a table giving dates of the arrival in England of 31 summer migrants during the years 1897-1968 and for these 72 years the author himself, or one of his brothers (Wilfrid —W.B.—or Christopher), has 68 annual records for five species (Swallow, Cuckoo, Whitethroat, Sedge Warbler and Swift) and never less than 28. Wilfrid was 'off birds' or out of England for some fifteen years, and Christopher was killed in 1917, so Horace must have been responsible for most of these observations. Or again, here is a section of a 6-inch-to-the-mile map of the area round Grantchester on which are recorded nesting sites found between 1910 and 1918, showing for instance that Willow Wrens occupied the same site in five of those years. On his eighth birthday Horace was presented with a book called THE NATURALIST'S DIARY: A DAY BOOK OF METEOROLOGY, PHENOLOGY AND RURAL BIOLOGY, and this he used till he lost it in Bombay in 1946 ('conditions of travel were still abnormal after the war', he charitably adds). In this book one page was given to each day, the left half divided into sections covering Weather, Plants flowering, Birds nesting, singing or migrating, Insects appearing 'and so forth' while the other half was left blank for the owner to record his own observations. This set a pattern which the author followed ever after. His eyes, ears and memory were abnormally reliable, as his records in *British Birds*, Witherby's HANDBOOK and elsewhere testify.

Horace Alexander was on the Council of the Royal Society for the Protection of Birds for more than twenty years and from his boyhood he has been associated with the work of the British Ornithologists' Union and the British Ornithologists' Club. He has participated enthusiastically in group migration studies, New Year's Day lists, county lists, etc. He was a member of the British Birds Rarities

Committee and has met and corresponded with a host of ornithologists. Yet he sums up: 'a day or even an hour spent in total relaxation just watching the birds has meant more than any scientific enquiry'.

What he calls the strangest happening of his seventy years of birdwatching occurred in New Jersy, U.S.A. It was the explosion of a small bird from the bonnet of a motor-car which had stopped for petrol. A few miles back the car had, to his horror, run over a sparrow-like bird which was feeding in the middle of the snowy road, and somehow it must have flown up into the engine and perched there until the bonnet was raised. Alexander's companion said it was a Whitewinged Crossbill (*Loxia leucoptera*), a rather occasional visitor to New Jersey in mid winter, so they drove back to the scene of the incident and were rewarded with the sight of three more, two females and a male.

The records of particular species at particular places, mostly in southern England, are of limited interest to ornithologists resident elsewhere, though they will learn much from this book as to the ways in which emphases have changed and keenness on bird study spread since the beginning of the century. Some more general questions too are asked. 'Do Birds Migrate over the Himalayas?' is the title of one chapter, in the course of which the author makes the dogmatic statement: 'No one is going to spend a couple of months sitting on a Himalayan glacier counting how many Stints, Hoopoes and trinomial pipits fly over.' Usually he is much more tentative. 'How birds do love to upset the things you confidently write about them' he reflects, after seeing a flock of 50 of a species he had labelled uncommon. The purposes, if any, of song, migration, tail-wagging and flocking in various species are discussed, leading to the conclusion that 'survival value' is a very partial answer. 'We struggle to survive; we aid one another in the struggle; and for much of our lives, even if we are birds or insects, we cease from struggling and enjoy life.' This book is solid evidence in support of the author's claim that birdwatching is 'not only an intense aesthetic experience, but also a stimulus to the mind and to the imagination, as one tries to understand the nature of a bird's world.'

R. E. H.

2. PLANT GALLS OF INDIA. By M. S. Mani. pp. 354 (22×14 cm). With 56 text-figures. Madras, 1973. Macmillan India. Price Rs. 80·00.

The science of the study of plant galls or cecidology has in recent years developed into a distinct biological discipline not only emphasising the close interrelationship between the gall former and the concerned plants, but also paving the way for a better understanding of tumorous growths of plant and animal tissues. The present volume by the eminent entomologist Prof. M. S. Mani, is yet another valuable contribution towards our understanding of plant galls besides his famous treatise on the 'Ecology of plant galls' and attempts to bring together the results of forty-five years of intensive study of galls from all over this country and parts of Afghanistan.

The introductory portion very briefly discusses all the significant aspects of galls such as the types of galls, the nature of their causal organisms, the intensities of galling on varied hosts, effects of infection and probable modes of differentiation in the affected tissues along with some interesting information on the histological and functional aspects of mature galls. Mention has been made of 'neoplastic growth' and of limited and unlimited neoplasms and their relative significance on gall structure which appear to offer fresh avenues in the exploration of biological intricacies with galls as the experimental material. A further highlight of this chapter concerns the distributional patterns of gall bearing plants in the Indian subcontinent, laying stress not only on the endemic types but also on those exhibiting affinities to Ethiopian and Mediterranean, European and middle Asiatic as well as to Indo-Chinese and Malayan regions. Laboratory procedures for the analysis and study of galls and methods of rearing of insects are also briefly discussed.

The major part of this compendium is devoted to the concise and systematic enumeration of galls classified in their respective natural orders. Nearly 750 identified galls belonging to 85 natural orders, with fourteen unidentified hosts and caused mostly by gall midges, mites, aphids, thrips, cynipids, nematodes, bacteria and fungi. The addendum provided, further describes thirty more recent records. Analysis of the general preference of gall makers to particular natural orders in so far as has been noted in the survey, shows that the families Leguminoseae, Moraceae, Lauraceae, Combretaceae, Anacardiaceae, Cucurbitaceae and Compositae are highly susceptible for gall infections. The synoptic, dichotomous keys provide easy provisional identification of the galls which have been briefly described.

The 103 references to literature on plant galls, the gall index giving the plant species, gall organisms and parts of the plants bearing galls as well as a detailed host plant index of cecidogenous organisms, inquilines, parasites, successori, etc. and a well compiled index to the host plants and gall makers make this neatly executed volume written by one of the foremost authorities on the subject, an invaluable source book to everyone—naturalists, students, researchers and teachers—interested in the fascinating study of the galls.

T. N. A.

3. GENERAL ENTOMOLOGY. By M. S. Mani. Second and Enlarged Edition. pp. xiii+597 (24×16 cm). With 185 text-figures. New Delhi, 1973. Oxford and IBH Publishing Co. Price Rs. 18·75.

This enlarged edition covers almost all aspects for 'fundamentals of entomology'; and it is written in entirely new form. The book is divided into two main parts. General part and Systematic part. General part covers anatomy, physiology, reproduction, development and growth, insect ecology, zoogeography and fossil insects. Chapters on anatomy, physiology, reproduction, development and growth are comprehensively but very briefly described which may be a little difficult to follow for new students. 'Insect and its environment', 'Geographical Distribution of Insects', and 'Fossil insects' are the chapters to which Prof. Mani has paid particular attention and seem to be the central point of this book.

The systematic part covers classification of insects, special characters, habits and relations between different orders. A key to the orders and keys to the families have been provided which should enable students to identify the family of a particular insect.

The book has a number of original, simple but clear text-figures.

The price, although not nominal, is certainly not high for the average Indian pocket, and the book is good value for the money.

M. D.

4. MAIN TRENDS IN PSYCHOLOGY. By Jean Piaget. pp. 72 (21·5×13·5 cm). London, 1973. George Allen & Unwin Ltd. Price £ 0·85.

MAIN TRENDS IN INTERDISCIPLINARY RESEARCH. By Jean Piaget. pp. 73 (21·5×13·5 cm). London, 1973. George Allen & Unwin Ltd. Price £ 0·95.

These are nos. 2 and 5 in the series *Main trends in the Social Sciences* produced by Unesco and published by George Allen and Unwin, London. Other works in the series are SOCIOLOGY by P. Lazarsfeld; ECONOMICS edited by I. Sachs, and DEMOGRAPHY by Jean Bourgeouis-Pichat.

Unesco carried out a study in collaboration with national and international research centres as well as individual scholars in the social sciences, and these small volumes indicate the present state and the future perspectives in the various disciplines covered. They are intended for the educated reader, the research worker as well as for institutions who organize and plan research studies.

Jean Piaget is an eminent psychologist and educationist whose work has influenced educationists all over the world. In these two volumes he has examined the conceptual framework, methods of study, and the influence these concepts and methods, in turn, have on our thinking and understanding of the subject. For instance, discussing the intelligence tests, when Binet was asked 'What is intelligence?', his answer was 'It is what my tests measure'. This was a wise answer since strictly, no other answer is possible. However, to measure intelligence in terms of such tests is itself 'limitative, and consists in measuring only the resultants or performances and not the actual processes which have produced them'. Unlike in Physics, where a certain result presupposes the underlying process or processes, we have no such exact knowledge about thought processes.

The applications of psychology in the social sciences, in medicine, in education and vocational guidance have been discussed together with the problems which arise in such applications.

In the volume on interdisciplinary research, the relationships between different branches of science, the epistemological background, the edifice of knowledge which is raised or its structure, and the interactions of these, one on another, are lucidly discussed.

These volumes are small, about 70 pages each, but the material and thought compressed in them is vast. No abstract or short review can do more than suggest the scope covered. For the worker in the social sciences, and, to an extent, in other fields also, the volume on interdisciplinary research offers a re-examination and analysis of current ideas, which, whether he agrees with them in their entirety or not, may well serve to reorient his thinking in his own field of work.

A. N. D. N.

5. FUNDAMENTALS OF HIGH ALTITUDE BIOLOGY. By M. S. Mani. pp. 196 (21·5×13·5 cm). New Delhi, 1974. Oxford and IBH Publishing Co. Price Rs. 42·00.

Studies on high altitude ecosystems have in recent years become an integral part of eco-physiological studies not only from the view point of the adaptations exhibited by animals and plants inhabiting these areas, but also from the view point of human endurance or acclamatization to high altitude conditions. This book by the 'Dean of High Altitude Entomologists', in all comprises seven chapters providing an astounding array of facts. Commencing with a brief introduction to the various factors of the high altitude environment which are 'closely and inseparably interlinked and intricately intertwined' into a complex constituting 'a self-regulating dynamic system', this book deals essentially with the two major aspects (1) high altitude plants and animals, (2) impact of high altitude factors on man. Numerous examples of high altitude plants particularly of the Himalayas, as well as those of insects along with their adaptive features provide interesting reading. Mention has also been made of the summit seeking species and their ecological significance.

A good portion of this volume devoted to the impact of the high altitude on man provides interesting information on the various physiological changes—respiratory, circulatory, neurohormonal and other changes—besides the action of ionizing radiations on man, more particularly on the human skin, as also of the high prevalence of cataract of the eyes in the permanent residents. The use of the term 'high altitude neurosis' is particularly interesting referring to the emotional sickness at high altitudes due to the cumulative effects of the complex factors.

The multiplicity of factors leading to the acclimatization of man to altitudes provides stimulating reading and the author with his long experience of Himalayan explorations concludes that 'the ability of man to tolerate high altitude conditions differs significantly even at comparable altitudes in different parts of the world' and 'that man lacks distinctive high altitude specialization' and that he is 'not an integral product of the high altitude ecosystem, but merely an intruder in it'.

An extensive bibliography comprising 449 references, a glossary to high altitude ecology and an index add to the usefulness of this volume. Written in an inimitably lucid style and incorporating a vast amount of data, both new and known, based mostly on the author's own experience over the past many years, this also provides available information on human acclimatization to high altitudes from Russian work. Besides opening up a new field to students of ecology, this book also provides stimulating information on applied aspects of ecology.

T. N. A.

Miscellaneous Notes

1. R. H. WALLER'S OBSERVATIONS ON WILDLIFE SANCTUARIES IN INDIA: A PARTIAL REJOINDER

It is unfortunate that excerpts from Mr Waller's account of wildlife sanctuaries in India (presented to the IUCN and WWF in 1970) should have been published in Vol. 69—No. 3 (December 1972) of *J.B.N.H.S.*, for to most readers unfamiliar with the sanctuaries mentioned and the ways of Indian wild animals, the very fact that these excerpts were published in the *Journal* will invest them with the semblance of scientific truth and credibility, qualities they do not always possess. It is always an unpleasant and thankless task rebutting errors in a note of this nature, for outside courts of law the burden of proof is most wrongly shifted from the person making the incorrect statements to the person questioning them—further, it is a simple matter to make an incorrect statement briefly and with the assumption of authority but takes a laborious and lengthy argument to rebut it, and the very length and tediousness of the rebuttal suggests to readers that where no much denial is needed, there must be some truth in the original allegation! Mainly for these reasons, this rejoinder is confined to Mr Waller's comments on the Sigur R.F., (Segur) and the Mudumalai and Bandipur sanctuaries, areas which I have known long and intimately: this does not mean that I agree entirely with him in his observations on other sanctuaries and his conclusions from such observations.

Had Mr Waller offered his comments as the casual impressions of a visitor to these sanctuaries, based mainly on hearsay (as I feel they are, in fact) there might have been no occasion for this rejoinder. But he says that he spent about 5 months in 1970 in 15 sanctuaries and faunal areas, mainly 'in the jungle', and that his report 'attempts to combine personal observation with certain scientific facts about ecological conditions and animal populations'. Such a report, when it is so manifestly mistaken in so many particulars, cannot be allowed to pass unquestioned. Mr Waller's comments on elephants in the Segur area are based on arbitrary presumptions and hearsay (possibly volunteered by those with a vested interest in the area), and completely ignore the recent past wildlife history of Segur and the surrounding forests. There is not an iota of truth in the frequently and loudly voiced claim of landholders in and around Segur to the effect that elephant populations in the Wynaad have increased enormously in recent years. The truth is that sustained and intensive human invasions of a vast elephant forest, not even peripherally but in ramified penetrations deep into the heart of these jungles, have so profoundly disturbed the wild animals that those of them given to ranging far (like elephants) are now to be found restlessly traversing their old trek-routes more frequently than before, and that naturally, with the reduction of their territory by human occupation, they are much more in evidence. It is a simple and inevitable consequence of deep, diverse and sustained human penetrations of their immemorial homes that elephants in the Wynaad, frequently disturbed and often injured by men, should be seen much oftener than before in transient local concentrations and that they are, naturally, aggressive towards humanity.

Mr Waller mentions the death of a German photographer here as proof of his statement: as one who has photographed wild elephants in India more often than any other, I can assure him that from detailed inquiries made on the spot soon after the event I am satisfied that the elephant was not responsible for its being provoked into killing that photographer.

Mr Waller's statement, 'They raid the neighbouring crops, having destroyed much of their own environment', is egregiously incorrect and provably so. In the entire Segur-Mudumalai Sa.-Bandipur Sa. area, there is not a single acre of forest that has been destroyed by wild elephants, and anyone knowing the feeding habits of *Elephas maximus* under normal conditions will know how patently incorrect such a statement is. It is humanity, and only humanity, that has destroyed the habitat of wild elephants in the Wynaad—by setting up hydel projects with all their concomitant clearings and pylons and high-voltage lines, by intensive exploitation of the forests departmentally and by individuals, by the sudden springing up of human settlements, agriculture, and herds of cattle in and around forests, by highways and by-ways criss-crossing the entire tract, and in many other ways, some of them insidious but potent. No wonder the elephants raid the crops growing in their old homes.

The remedy, surely, is not to shoot down the already much-shot-at elephants of the Wynaad, but to provide them with an adequate area freed from human disturbance. This is what is being attempted in the Wynaad under Project Tiger, and perhaps in the Kerala-Tamil

Nadu-Karnataka interstate sanctuary proposed. Even so, used to a much larger range only 30 years ago, elephants will roam out of the protected areas, especially if crops are grown on their outskirts, but if it is then necessary to shoot them, not for any fault of theirs but because of established human rights on these outskirts, it may be ordained that they should be shot—in fact, this is the only prediction I have made in my recent ecological survey of the larger mammals of the peninsula.

Seldom has anything so anthropomorphic and self-defeatist been suggested in recent years in wildlife circles as Mr Waller's suggestion that dhole should be shot down, because they will hunt sambar to extinction in Segur. Firstly, he is wrong in saying that sambar constitute the main prey of dhole in the area, and that chital escape more readily from the predator. Ground birds such as junglefowl and peafowl, monitors and other reptiles, field rats, hares and even porcupines, deer of all kinds, pig, and occasionally the young of gaur and even more rarely domesticated calves are the main prey of dhole in and around Segur, and in my experience, chital are the most frequent prey of dhole here. With the tiger and panther on the decline, dhole are of special importance in maintaining the balance of nature here: but for them, the herbivores would overrun the jungles. The role of predators like the dhole in maintaining the balance of nature is, in fact, almost patently evident in the Segur area, and the observations of Schaller and others on the wild dog in Africa (published within the past 2 or 3 years) will further add to my point. Being so much smaller than many of the animals they hunt, dhole sometimes (infrequently, in a pack they kill quickly enough) literally eat their victims alive, and sometimes wait for them to weaken after maiming them, before killing them; Tinbergen and others have pointed out how the most deadly of avian predators, the peregrine, will not stoop at a flock of close-flying birds when there is the risk of violent collision with a bird next to its chosen victim; for all its superb muscular co-ordination and agility, a leopard will not jump down from a three-foot high rock (as a man will) but will glide down to the earth. Predators cannot afford injury, and avoid it instinctively. Dhole do not expose themselves to injury, even in the death-throes of their victims, being predators. Nervous shock, loss of blood and fright seem to combine to virtually anaesthetise the victim in such circumstances, and it suffers itself to be eaten piecemeal. Not a pretty sight, but that is the only way dhole can get their meat at times. It is not for us to try and be wiser than nature, and anyway, who are we to comment on the cruel ways of lesser killers!

Except when breeding, dhole range far and are seldom confined to a locality. In the course of thousands of years, dhole and deer have coexisted in the Wynaad, without any noticeable decline in the populations of the latter. Surely Mr Waller should know that even with artificially imposed factors conditioning wildlife in a locality, there is never the risk that the predators will kill out the prey, because invariably the predator dies out in advance of the prey? Moreover, apart from theoretical arguments, prior to 1968 there was no noticeable diminution in the numbers of sambar in the Segur-Mudumalai Sa.-Bandipur Sa. area. If subsequently there has been a slight decline, surely that is to be attributed to the disastrous rinderpest epidemic of 1968, and not to dhole.

Regarding the effects of rinderpest on gaur (gaur were easily the worst affected by the epidemic) in the Mudumalai Sa.-Bandipur Sa. area in 1968, from where did Mr Waller get the figures he provides so confidently? I was in Bandipur on the heels of the epidemic, and naturally tried hard to get all the statistics and observation records I could, especially as there were some interesting aspects of the disaster, suggesting an instinctive defensive (or rather prophylactic) behaviour in the animals afflicted. Moreover, I am specially interested in gaur, and had, only 2 years earlier, warned the Madras Government (as it was then) of the impending epidemic and suggested remedial measures, at the completion of a survey of the Mudumalai Sa. spread over 6 years that I had taken on. I wandered all over the most favoured haunts of gaur in both sanctuaries in 1968 (only Bandipur), 1969, and 1970 (only Mudumalai), and also hired tribals to bring in counts of carcasses and skeletal remains, and still I was able to get only figures from which a broad approximation could be made. Mr Waller says that in these 2 sanctuaries '90% of the gaur died—probably 1000 animals' as the result of the epidemic. He adds, 'skulls now litter the two sanctuaries as a reminder of what can happen when there is no control of cattle infiltration—the undoubted spreader of the disease', and goes on to provide percentages of deaths caused by the disease among sambar and chital.

Such statements are, I submit, unworthy of a scientific report. With a much longer time spent in both sanctuaries, with a much more intimate knowledge of the gaur tracts in both and with a greater incentive for getting reliable figures for my own report, I was unable to count more than 20 skeletal remains in both areas (except for a negligible number, the gaur that died of the epidemic in Bandipur were buried deep or burnt). I can assure the reader that skulls do not litter the 2 sanctuaries now, and did not in 1969-70. I looked for them.

Granted that about 1000 gaur died in the two sanctuaries of the epidemic disease (many outside the sanctuaries—they wandered away outside to die), on what basis does Mr Waller get his 90%? The gaur population of this tract is not resident, but a shifting population, and during July-August 1968, when rinderpest took heavy toll of the victims, many of the gaur would have moved out of the Mudumalai sanctuary, where the tall grass is rank and coarse by then. I think the 90% Mr Waller provides is an exaggeration. Guesswork should not take the place of counts in statistical work.

2/14, EDWARD ELLIOT ROAD, M. KRISHNAN
MADRAS-4,
October 9, 1973.

2. RECORD OF A PIEBALD FULVOUS FRUITBAT, *ROUSETTUS LESCHENAULTI* DESMAREST

(*With a text-figure*)

Instances of albinism and aberrant colorations of the fur have been recorded in bats. Setzer (1950) in his review of albinism in bats mentioned the occurrence of albinism in the genera *Rhinolophus, Glossophaga, Myotis, Pipistrellus, Eptesicus, Lasiurus, Antrozous, Chaerephon* and *Molossus*. Glass (1954) and Metzger (1957) recorded aberrant coloration and partial albinism in *Tadarida mexicana* and *Myotis sodalis* respectively. Mitchell (1963) reviewed the records of occurrence of albinism and aberrant coloration in *Tadarida brasiliensis mexicana* and reported an instance of aberrant coloration in *Tadarida femorosacca*. The present report records a case of piebaldism in the Indian fruit bat *Rousettus leschenaulti* Desmarest, 1820

The specimen, a juvenile male, was obtained from a colony in a subterranean laterite cave at Muroor, North Kanara District, Karnataka State, India, on 20th August, 1972. The colony had an estimated population of 10,000 individuals of normal coloration. The coloration of this piebald specimen made it very prominent and it was easily picked up with a sweep net.

Dorsally the specimen has a white patch on the back. Ventrally a white bar runs diagonally across the middle of the body and extends

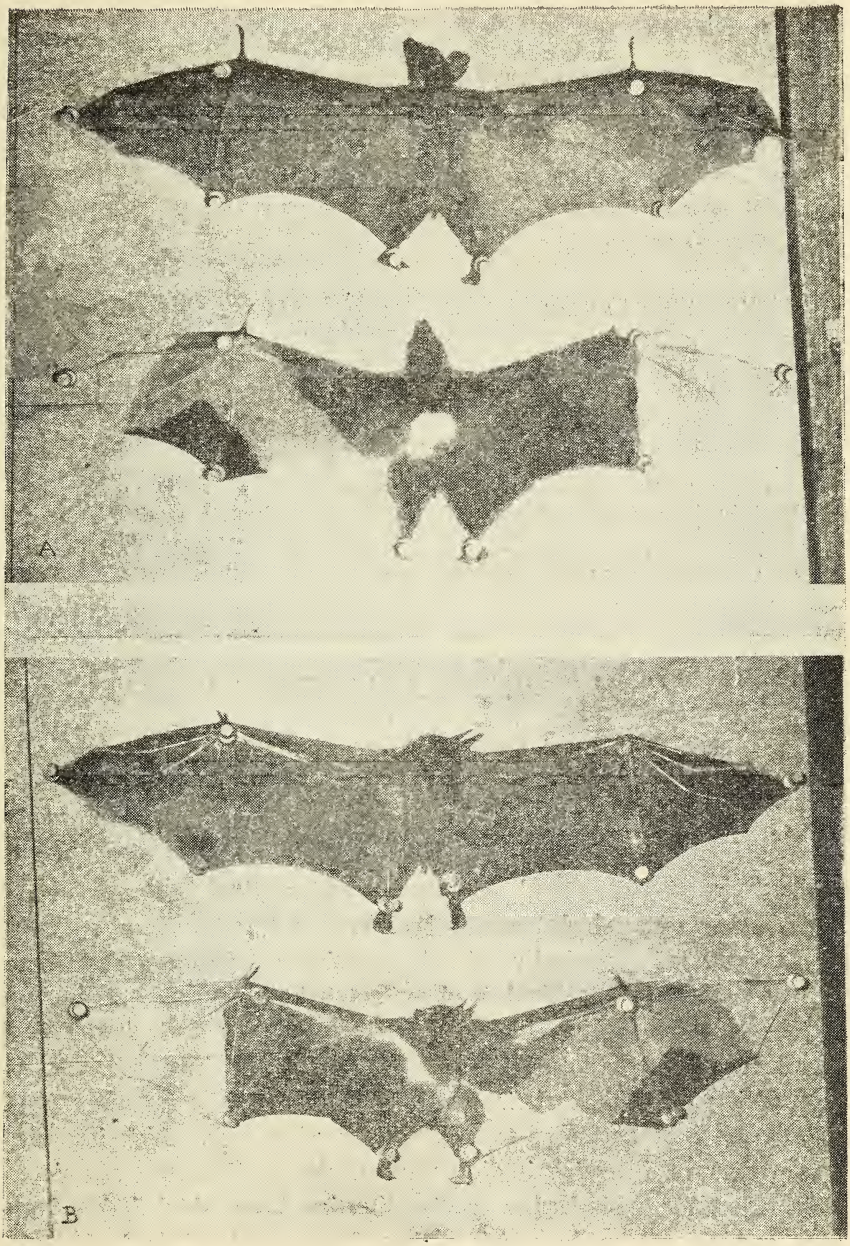


Fig. 1. Dorsal (A) and Ventral (B) aspects of the piebald specimen of *Rousettus leschenaulti* along with a specimen of normal coloration.

to the right forearm. Both wing membranes have large irregular patches of unpigmented areas (Fig. 1).

Apparently this is the first record of piebaldism in the genus *Rousettus.*

ACKNOWLEDGEMENTS

We thank Dr N. P. Gupta, Director, Virus Research Centre, Poona, for the constant encouragement, and Dr J. E. Hill of the mammal section, British Museum (Natural History), London for valuable suggestions.

VIRUS RESEARCH CENTRE,
POONA,
June 18, 1973.

M. A. SREENIVASAN
H. R. BHAT

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3. NEW METHODS OF COLLECTION OF BATS

Methods of collection of species of bats living in small colonies in obscure and inaccessible places for a thorough survey do not appear to be satisfactory because they depend largely on chance. During a bat survey of Jabalpur city and environs, a method for collection of such species was developed and applied and resulted in the collection of twenty species which, except three rare and rather poorly known forms, included practically all the species so far recorded from Central India. The method is described below:—

The method consists in moving about at dusk and dawn when the bats leave or enter their roosts respectively. If a specimen is seen during these hours, it is certain that it cannot be far away from the roost. It is necessary to note the direction from which it comes out at dusk or in which it disappears at dawn. The next step is to wait at a place a bit farther up the direction from which it has been seen coming out or in which it has disappeared. This is because there is a general tendency among the species studied to follow a restricted path while leaving and entering the roost. After a few attempts, generally from 1 to 3, the haunt of the specimen can be easily located. The location is facilitated by the fact that in most cases the forms under consideration live in colonies of varying number and they generally enter or leave their haunts one or two at a time so that the process of departure from and return to the haunt of the whole colony is spread over a considerable period depending upon the size of the colony. After the location of the haunt the specimens can be collected by various common methods depending upon the nature of the haunt. Two of these, however, need special mention.

(*a*) If the specimens are hidden in deep holes, they can be collected by tying a butterfly net around the haunt. Most of the specimens easily enter the net when they come out in the evening.

(*b*) If the haunt consists of crevice having one or a few openings, the openings except one are blocked with cotton or other material and cigarette smoke is blown into the hole for a few minutes till the bats come out. This method can be used for collection during any time of the day.

Only a few individuals should be collected and the rest left for observation in their natural habitat which they do not generally leave for sometime if the collection does not involve considerable disturbance.

The method has been found suitable especially for the following species: *Taphozous l. longimanus* Hardwicke, *T. k. kachhensis* Dobson, *Rhinolophus l. lepidus* Blyth, *Hipposideros f. fulvus* Gray, *H. galeritus brachyotus* Dobson, *Pipistrellus c. coromandra* Gray, *P. m. mimus* Wroughton, *P. ceylonicus indicus* Dobson, *Scotozous d. dormeri* Dobson and *Scotophilus h. heathi* Horsfield.

Central Regional Station,
Zoological Survey of India,
Jabalpur, M.P., India,
December 9, 1971.

H. KHAJURIA

4. A NOTE ON BODY COLOUR AND BREEDING HABITS IN CAPTIVITY OF COMMON PALM CIVET (*PARADOXURUS HERMAPHRODITUS*) OF ORISSA

Prater (1971), has described the normal body colour of the common Palm Civet as 'black or blackish-brown civet with long coarse hair . . . , the new coat, before it is fully grown, generally shows a pattern of longitudinal stripes on the back and spots on the flanks, shoulders and thighs. The limbs are always black or dark brown. Facial markings variable, ...'

Four young common Palm Civets (*Paradoxurus hermaphroditus*) were procured from Simlipal National Park in Mayurbhanj district of Orissa on 8-v-70 at an estimated age of 20 days. Their body colours were:—

(*a*) in two females and one male creamish-white throughout the body coat except the face, head, upper parts of the neck and shoulders from the elbow joints or the middle of the external side of the fore-arms upwards and are large or two small patches at the base of the tail, which were black in colour. The hind limbs and fore-limbs below the elbow joints or middle of the fore-arms were creamish-white. White patches or spots below and above the eyes were present;

(*b*) in the other male the body colour was black except at the tip of the tail of 5 cm length which was creamish-white and white spots below and above the eyes were present.

Breeding:—One of the females described above under (*a*) was allowed to remain with the male, (*b*) at the Nandankanan Biological Park (Orissa) from 6-x-70. Copulation was observed from 30-i-71 to 1-ii-71. On 3-iv-71 the female gave birth to three young (males) (gestation period of 60 days). The colour pattern of the body coat of the young was almost the same as described above under (*a*). The birth weight of the young was from 69 to 102 gm (average of 83 gm) the length from tip to tip was from 28 cm to 30 cm with an average of 29 cm and the tail length was from 11 cm to 13 cm with an average of 12·2 cm. The eyes were closed at birth and the young were fully furred. Two of the three young were eaten by the mother within 24 hours of birth. The eyes of living young opened on the 10th day. The young was seen taking banana along with the mother at the age of 6 weeks onwards. The mother carried the young by holding the middle of the body. The young one which weighed 102 gm at birth, weighed 995 gm on 3-vii-71 (3 months).

There is no mention of birth weight and size, gestation period, and age of opening of the eyes of the new born young in the available literature (Prater, loc. cit.; Walker *et al.* 1964; Asdell 1964; Crandall 1965). The litter sizes are given as 3 to 4 (Prater loc. cit.), 3 to 4, sometimes as many as 6 (Asdell loc. cit.) and 2 to 4 (Walker *et al.*, loc. cit.).

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We are grateful to Dr M. M. Patnaik of State Veterinary Laboratory, Bhubaneswar-3 for going through the manuscript critically.

NANDANKANAN ZOO, L. N. ACHARJYO
BARANG, (CUTTACK).

NATIONAL PARK, A. P. TRIPATHY
JOSHIPUR, (MAYURBHANJ),
September 15, 1971.

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5. AN OBSERVATION ON THE BEHAVIOUR OF NILGIRI TAHR (*HEMITRAGUS HYLOCRIUS*) WHEN THREATENED BY WILD DOG OR DHOLE (*CUON ALPINUS*)

About five o'clock one evening while returning from the Erivikulam camp I saw a large herd of Tahr on a ridge above the path. As the wind was favourable I decided to stalk them and try to take some photographs.

On reaching the ridge top I found that they had moved about 100 yds over the crest and were standing in a tightly bunched group above a fairly steep cliff face. The fact that they had moved while I was stalking them surprised me at the time, as they could neither have seen nor scented me during my approach. The herd numbered approximately 80 animals and consisted of all age groups from kids of about four months to yearlings and immature and mature bucks and does. I approached under cover to within about 30 yds and from there began to photograph them. In order to do this I stood up and was greeted by alarm sneezes when they saw me. They did not, however, exhibit their usual behaviour in these circumstances. Normally they wheel round and bolt a few yards, before finally making off altogether when they have established that the cause of their disturbance is human, or else they take to the cliffs. Instead of this they gradually approached me *en masse* until the nearest were about 20 yds away. A strong breeze from the North was blowing from them to me.

Suddenly I saw two magnificent Wild Dog approaching the herd at a fast lope down wind from the North. When they were about 100 yds away the dogs circled to the West and very quickly arrived on the ridge over which I had stalked. At this point the dogs evidently scented me, for they turned about and raced back the way they had come, moving at an incredible speed and seeming to glide across the face of the hill, their rich red coats and black tails standing out against the newly-sprouted grass. When about 400 yds away both dogs stopped and emitted a series of high-pitched yaps of penetrating loudness. At this the whole Tahr herd wheeled round and faced the direction of the dogs, but made no attempt to move either on to the cliff or away. The two dogs then raced on and were joined by four other adult dogs and five small pups of about 4-5 months, all of which had evidently been lying in the grass from where the two dogs had originally come. The whole pack then made off out of sight.

It was most unfortunate that the dogs detected my presence when they circled the herd, otherwise I should have been able to witness their method of attack on the Tahr. One can only speculate that they intended to approach the herd up-wind and then would have attempted to stampede the Tahr—or at least some of its less staunch members—in the direction of the pack. Had this failed would the rest of the pack have been called up and an attempt have been made to grab a Tahr out of the herd? It is likely that the herd on being closely approached would have moved onto the cliff face where, still tightly packed together and presenting their heads to the dogs, they would probably have been a match for them if they had tried to approach within seizing distance across the steep rock face.

Cases have been cited of Sambar and Chital seeking the protection of humans when hard-pressed by Wild Dog. They also show no apparent fear of humans when, after the Wild Dog have been dispersed, their human saviour has escorted them out of the water in which they have sought safety. This would probably account for the unusual attitude of the Tahr when they first detected me, for their reason for bunching together above the cliff was presumably due to the fact that they had seen or winded the Wild Dog before my approach.

I can only assume that the yapping was emitted either out of frustration, or that it was a signal to the rest of the pack that their attack on the Tahr had been foiled.

Shortly afterwards, when I withdrew in full view the Tahr remained in the same position, and an hour later when viewed from a distance they were still there, though some were lying down and others were grazing nearby.

It is probable that the Wild Dog had little difficulty in finding a meal elsewhere that evening. At this time of the year after the grass has been burnt off and is sending up new shoots, both large mixed herds of Tahr and small parties of bucks of the same species may be found grazing all over the plateau and Wild Dog are easily able to course and pull down some of them before they can reach the safety of the cliffs.

LOWER VAGAVURRAI ESTATE,
TALLIAR P.O.,
KERALA STATE,
May 10, 1974.

J. C. GOULDSBURY

6. FOOD REQUIREMENT OF 'BLACK RAT', *RATTUS RATTUS* L.

There have been several investigations on the food consumption of 'black rat' *Rattus rattus* L., (Harrison & Woodville 1950; Majumdar *et al.* 1966; Parrack 1966). But realising the regional variation in size and weight of this species (Harrison & Woodville 1949; Deoras & Gakhale 1958), it seemed desirable to estimate the food requirement of the rat, *Rattus rattus rufescens*, caught from various localities of Aligarh city. The results are reported here, together with an attempt to calculate the figure for translating food takeon into number of rats for census work.

Rats caught in 'wonder traps' were weighed and sexed by standard procedures (Evans *et al.* 1968). Pregnant females were excluded, and others were housed individually in wire-mesh cages of 1·17×0·88×0·35 m. The rats received a weighed surplus of unextracted wheatflour (wholemeal) in 15 cm diameter glass dishes. The residue was weighed on the succeeding day and the difference recorded. Replicates were run in all cases; and the observations continued for a minimum period of ten days. There was an unlimited supply of drinking water. The data was statistically analysed by recommended methods (Bailey 1958; Chakravarti *et al.* 1967).

Table 1 makes clear the relationship between the amount of wholemeal eaten and body-weight of the rats. Juveniles weighing 45 gms or 50 days in age (Spillett 1966), consumed daily an amount of food equalling 21·35% of their body-weight. The figure decreased to 15.57% for sub-adults of 85 gm and 80 days in age; and varied from 8 to 11% for adults above 130 gm in weight. Evidently, consumption was high in fast-growing juveniles and sub-adults, and tended to level-off in older age groups (Harrison & Woodville 1950; Leslie & Ranson 1954; Majumdar *et al.* 1966).

TABLE 1

ESTIMATED INTAKE OF WHOLEMEAL PER DAY BY THE RATS.

Body Weight (gm)	Mean Daily Consumption (gm)	Mean daily Consumption % of Body Weight
35	8·7	24·86
45	9·6	21·35
55	10·4	18·9
65	11·3	17·38
75	12.5	16·55
85	13·2	15·52
95	13·8	14·52
105	14·1	13·4
115	14·4	12·09
125	14·7	11·7
135	14·8	10·9
145	15·0	10·34
155	15·4	9·93
165	15·5	9·39
175	15·8	9·02
185	16·2	8·75
195	16·3	8·35
210	18·6	8·85

The same exponential relation was demonstrated when logarithm of food consumption (y) was plotted against logarithm of body-weight (w). The calculated line of best fit log y=log a+b log w, was given by:

$$\log y = \log 0.3464 + 0.3853 \log w \text{ or } y = 0.3464\, w^{0\cdot 3853}$$

It was compared to similar data reported for brown rats Leslie & Ranson 1954). The hypothesis H: a=T. 5396, b=0·3853 was tested by the F-test for assigned linear regression (Chakravarti *et al.* 1967). The test statistics was found to have the value 2·1856; which when compared with the tabulated value at (2·23) degrees of freedom, was significant at 5% level. This establishes the acceptance of the present results.

The weight-structure of a representative population of black rats in Aligarh, may be taken from the records of 600 rats examined from July, 1971 to May, 1972. The data is summarized in Table 2, with observed weight distribution expressed per 1000 rats. The relationship demonstrated between food intake and body weight of rats (Table 1), gives a working basis for calculating the average consumption of wholemeal per member in this population.

TABLE 2

WEIGHT-STRUCTURE AND FOOD REQUIREMENTS OF THE 'BLACK RAT' POPULATIONS

Weight Group	Number of rats
up to—20	10
20-29	30
30-39	35
40-49	45
50-59	30
60-69	25
70-79	50
80-89	50
90-99	60
100-109	90
110-119	55
120-129	80
130-139	80
140-149	95
150-159	80
160-169	65
170-179	60
180-189	20
190-199	10
200-209	25
210-220	5
Total	1000
Mean Body Weight (gm) ..	110·4
Estimated average consumption per member per day	13·5

According to Leslie & Ranson (1954), consumption per member per day can be calculated for a given population 'by applying the daily consumption of wheat calculated for the pivotal weights to the observed frequencies in each weight class and summing'. Presently this comes to 13·5 gm wholemeal consumed/member/day. The range of this average calculated from range of error of the regression line (0·3853± 0·08085) is negligible. The take of wholemeal in gm divided by the factor of 14 would give the approximate number of rats in a population of this weight-structure (Table 2). Apparently the same factor can generally be used for census work; if the populations are not known to differ basically from that considered presently.

ACKNOWLEDGEMENTS

We are thankful to Professor S. M. Alam, Head, Zoology Department, AMU, for facilities and encouragement. Special thanks are due to Dr S. N. U. A. Kirmani, Department of Statistics, AMU, for helping with statistical calculations.

ZOOLOGY DEPARTMENT,
AMU, ALIGARH, (U.P.),
May 30, 1973.

DEVENDRA BHARDWAJ
JAMIL AHMAD KHAN

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7. GOLIATH HERON IN THE SUNDERBANS, WEST BENGAL

While on a visit to the Sunderbans I observed a Goliath Heron (*Ardea goliath*) at the mouth of one of the creeks on 22 March 1974. Although I had not seen the bird before I am quite familiar with this impressive heron from photographs and had, indeed, hoped to see it when in Africa. The Goliath heron was not in my mind when soon after dawn we approached the mouth of the creek in the Forest Department's launch

Banashree. I spotted a heron feeding and it took off as I raised my glasses and flew slowly in front of me. I had no hesitation in exclaiming 'Goliath heron', but checked myself at the thought that I had never heard of it in the Sunderbans area.

On my return to Calcutta I consulted Finn (cannot remember title) and found that Goliath herons had appeared in Calcutta market in 1845-46. I was later able to consult the HANDBOOK and found that the Goliath heron had last been recorded in 1925 in the Khulna Sunderbans (now in Bangladesh), only a few miles from where I found it.

The HANDBOOK describes the Goliath heron as essentially an African species, and a rare vagrant to India. Apart from the records in the Calcutta market and the Khulna Sunderbans already mentioned, Hume saw six gigantic herons near Multan in 1873 which were probably Goliaths, Blanford saw one near Nagpur and one in Baluchistan, and Stuart Baker saw five on the Meghna near Dacca in 1910. Ceylon has records in 1878 and 1879 but not since.

It seems probable that the Goliath heron is regularly to be found in the Sunderbans area, and the lack of reports is solely due to the absence of knowledgeable bird watchers. The great size and fine plumage resembling a brighter coloured Purple heron are distinctive.

1100, MORGES,
SWITZERLAND,
May 30, 1974.

PETER F. R. JACKSON

8. ? THE LITTLE GULL, *LARUS MINUTUS* PALLAS, IN KUTCH

On visits to the Great Rann of Kutch in April 1956, April 1957, March 1960, and again as recently as January 1974, I observed rather distant flocks of a puzzling gull which it struck me at the time could, by all the rules of the game, be no other than the Little Gull, *Larus minutus* Pallas. I did not publish this earlier in view of the extreme paucity of records of this species in the Indian subcontinent (a single specimen from Ladakh, and a possible sighting in Bombay Harbour--INDIAN HANDBOOK **3**: 37), and lack of positive conviction on my own part. However, on the latest visit to the Rann (23/24 January 1974) I was able to watch a fairly large flock sufficiently closely to support my earlier conjecture, though confirmation must still await a specimen. At first the birds, which were in winter plumage, looked like winter

Blackheaded Gulls (*L. ridibundus*), but their comparatively diminutive size was immediately distinctive, as also the absence of any black in the primaries. The blackish bill suggested Gullbilled Tern (*Gelochelidon nilotica*), but the white tail was not forked as in the latter. The blackish underwing, tern-like flight (with rapid wing-flapping) and habit of flicking food off the water surface--and of course the small size for a gull—are the points on which my tentative identification rests. What other species it *can* be is difficult to guess!

46, Pali Hill, Bandra,
Bombay 400 050,
May 27, 1974.

SÁLIM ALI

9. WHITECHEEKED TERN *STERNA REPRESSA* HARTERT IN BOMBAY

On 26th June 1973 a tern with one leg almost completely missing below the tarsal joint was brought to me by a local boy who had picked it up on the beach. Though the wound appeared to have healed the bird died within a few hours, no doubt due to other causes, and I sent it to the Bombay Natural History Society where Mr Humayun Abdulali has identified it as *Sterna repressa* Hartert.

This species is known to nest on the Vengurla Rocks off Ratnagiri, southern Maharashtra, but this is the first record from the Bombay neighbourhood. I referred to the Regional Meteorological Centre, Colaba, Bombay to know the prevailing weather conditions and was informed that from 24th to 26th June there was no stormy weather but a northwesterly wind with a speed of 5 to 10 knots prevailed.

The primaries and tail are both in moult but the black cap on the head precludes its being an immature.

Sir Mohamud Yusuf Trust,
C. I. Campus,
Nhava *via* Panvel, Kolaba District,
Maharashtra,
July 26, 1973.

PRABHAKARA MENON

10. NOTE ON THE COLLAR APPEARANCE IN THE MALE ROSE-RINGED PARAKEET, *PSITTACULA KRAMERI* (SCOPOLI)

The adult male of rose-ringed parakeet, *Psittacula krameri* (Scopoli) bears a rose-and-black collar which is lacking in the female. The fledglings as they leave the nest do not show any such external secondary sexual character. Fourteen nestlings (about 30-40 days old) of rose-ringed parakeet were, therefore, collected and reared in the laboratory in May, 1971 to determine the age at which the collar appears in the male fledglings. The black collar started appearing in the beginning of September, 1971 at the age of 4 months of the fledglings in the form of a faint thin line just on the sides of the neck and then extended underneath the lower mandible, which subsequently deepened in colour. It was complete in form and colour in three months. The rosy collar first appeared in the form of a spot on the dorsal surface of the neck at the end of April 1973 at the age of 23 months, which, then descended on the sides of neck along the black collar. It took 4 months for its completion. The rose-and-black collar in the male parakeet thus appears fully at the age of 27 months.

Punjab Agricultural University,
Ludhiana,
March 4, 1974.

G. S. SIMWAT
A. S. SIDHU

11. EXTENSION OF THE RANGE OF CETTI'S WARBLER *CETTIA CETTI ALBIVENTRIS* SEVERTZOV

The Society's Bird migration study party at Bharatpur, Rajastan (27° 13′ N.; 77° 32′ E.) netted a warbler which was not readily identifiable in the field. The bird, collected and preserved on 30th October 1971, was later identified by me at the Society's bird room as Cetti's Warbler *Cettia cetti albiventris* Severtzov, and confirmed by Dr Sálim Ali. The bird breeds in the area ranging from Iran to Russian Turkestan and winters south to southern Iran and Afghanistan. According to the available literature its wintering range within the Indian subregion is confined to the Indus Valley west of River Indus, from Peshawar in the north and Sind in the South, Bharatpur lies approximately 800 km east of the Indus river and possibly its occurrence in similar biotope east of Sind might have been overlooked all these years. A species which affects inundated reed-beds and tamarisk bushes along the freshwater reservoirs and saline backwaters it is an inveterate skulker, more often heard than seen.

Hume, who says '. . . . personally I (A.O.H.) consider the individuals of this species the most unmitigated little beasts that ever bothered an ornithologist', gives the following amusing account of his attempts to obtain this bird in Sind:

> '....On several occasions when boating about in gloomy rush and tamarisk swamp I caught glimpses for a second of a small dusky long-tailed bird fluttering about the stems of the centre of the tamarisk bushes; each time I mentally resolved, "next time I see that fellow, I'll shoot him". This went on for several days; but I never once *did* see him; a momentary glance in the centre of a thicket was all that was ever vouchsafed, and so I made up my mind that I *must* get a specimen, *coûte que coûte.* At last having seen, or fancied I saw, one in a small island of rush, about 40 feet square, in which some dozen dense tamarisk bushes were growing, I set to work systematically, and made six men beat through it in the expectation that the bird would, at any rate when thus pressed, fly out into one of the many neighbouring similar little islets; no such result however followed; one of the men saw it flit by him and that was all. This process was repeated five or six times, but with no better success ; then I made up my mind to go and beat through bushes myself, which as the water was cold, and with mud fully three feet deep, was unpleasant. I drew the charges of my gun, put in only about ½ drachm of powder and ¼ oz. of dust shot in each barrel, and went in for mud-larking operations in earnest. Three times I beat the clumps backwards and forwards without catching a glimpse of the wretched little creature; getting my hands and face scratched and cut, with the reeds and tamarisk branches, besides getting up to my waist in a hole at the root of one of the bushes, yet as each time one of the party saw it, I felt bound to persevere; the fourth time the bird suddenly appeared at the muzzle of my gun, darted, I believe, between my legs, where there couldn't have been much room, considering the depth of water, and disappeared. I duly let the gun off, but I had reason to suppose, in exactly the opposite direction to that in which the bird at the moment was; then I altered my tactics and stood quite still in the middle of the clump, whilst I made the men beat from the other side. This was obviously the right plan, for the very first time I got a shot, at least seven feet off the muzzle of the gun, and blew the bird *entirely* to pieces; besides, unfortunately, peppering one of the boatmen so soundly, that though it was only dust shot, they positively refused to beat any more upon that system. This was by many degrees too bad; I had no special grudge against the species to begin with; but then and there registered a vow that an ample series should give me my revenge; accordingly for many hours of two days I devoted myself entirely to Cetti's Warbler. Every little dark dense patch of rush, reed, and tamarisk, standing out in the water contained one or two of these atrocious little skulks, the thing was to *bag* them. I never but once succeeded in flushing any one of them, and then I missed him, at least so the boatmen said. I did not admit the fact at the time, and I don't see why I should now, but anyhow the *corpus delicti* was not produceable. I never got a shot more than three yards

distance from the muzzle of my gun, and I absolutely blew to pieces more than half of the specimens I did succeed in shooting, and all I can say further is, that having established the occurrence of the species in India, any one else may go and shoot them who pleases, no one will ever catch *me* at it again.'

(A. O. Hume, 1873 *Stray Feathers* 1: 192.)

Bombay Natural History Society, S. A. HUSSAIN
Hornbill House,
Shahid Bhagat Singh Road,
Bombay 400 023,
October 30, 1974.

12. NEST CONSTRUCTION TECHNIQUE OF THE SPOTTED MUNIA, *LONCHURA PUNCTULATA*

Spotted Munia is known to breed, wherever it occurs, throughout the year, intermittently but mainly during the rains. (Hume 1890; Ferguson 1904; Baker 1926, 1934; Whistler 1928; Ali 1953, 1961). At Poona too for the past 9 years or so I have come across the nests of this species during the rainy season i.e. from June to September. I have noticed most nests with eggs in July and most nests with young in August.

This species is known to construct a rather clumsily put together globular nest of grass, bamboo leaves, leaves of jowar and bajra and in Bengal even jute fibre (Baker 1934: 27). The normal diameter of the nest globule varies from 20 to 24 cm but extremes of 7·5 cm and 45 cm have been on record (Baker 1934: 27). There is a lateral entrance hole usually between the middle and top of the globule. The nests are generally placed in thorny bushes or small trees at any height from 1 to 6 metres from the ground. Whereas the foregoing information regarding the breeding season, shape, size and location of nests and the nesting materials used is already well known, the nest construction technique, i.e. mode of shaping the nest preferred time of the day for construction, number of trips made by the birds in search of nesting materials, the selection of nesting materials at various stages of nest construction and time taken for construction, have not been recorded so far.

Last August I had an opportunity to observe closely the nest construction technique of this species while a pair constructed their nest in a small *Thuja orientalis* tree in the compound of a residential bungalow in a Poona suburb. On 21st August at about 2 p.m. I noticed a spotted Munia emerging from the grass patch in a vacant lot in front of my house, with a large blade of grass held in the beak. After a minute or so another one was sighted carrying a blade in the same direction. Still another blade was whisked away after another minute or two. The birds carried the long blades held firmly in the beak and the folded legs, stretched across the breast and abdomen, fluttering free under and behind the tail. While carrying these large grass blades the birds flew rather low, about 1-2 metres above the ground.

Obviously a nest was being constructed nearby. I came out of the house and followed the birds to the small thuja tree, approx. 5 metres high, growing inside the compound of my neighbour. The birds with grass blades kept on arriving, perching for a while and then disappearing in the thuja tree for another two hours at the rate of 3 to 4 times every ten minutes. At 4 p.m. two Spotted Munias emerged from the tree, sat for a few minutes on a telephone wire nearby before flying away together in a direction away from the grass patch. When they did not return for about ten minutes or so I ventured near the *Thuja* tree and parted the branches to have a look at the nest. The construction had been started in a vertical fork about 2 metres from the ground. The long blades of grass had been loosely woven across the thin leaflets in a circular fashion to shape the sphere. The blades were not placed very close together. Light could be seen through the gaps, especially the large one in front.

I kept a look-out for the birds next morning, i.e. on 22nd August. It was a bright sunny morning. The birds appeared at 8·20 a.m. and started the construction work. They made 228 trips bringing in the nesting material, in five hours, averaging 45·6 trips an hour. The average decreased to 35 trips an hour during two hours of slight drizzle and rose to 52·6 in three hours of bright sunshine.

It started raining shortly after 1·30 p.m. I abandoned the observation post and later discovered that the birds too had called it a day. In the evening I checked the nest. The globule had taken shape. The walls were still thin, hardly 2 blades thick and the entrance hole had taken shape.

On the morning of 23rd there was a light rain. It stopped at about 10.30 a.m. The birds appeared shortly afterwards and took up the construction. They made on an average 44·2 trips an hour during the 5-hour observation period from 11.00 a.m. to 4.00 p.m. Number of trips in the forenoon being more than in the afternoon, In the evening when I checked the nest the walls of the globule were found thicker. The fresh material was found incorporated on the inside.

On 24th August I could not make any observations. On 25th when I reached the scene at 9 a.m. the work was already in full swing. I clocked 48 trips on an average for the next three hours and took some photographs. The birds were still bringing the long and broad leaves of *Urochloa panicoides.* I parted the branches to have a clear view of the entrance. The birds (both of them) were now flying in with the material. One of them stayed inside obviously doing the construction, while the other made the material hunting trips. The work continued throughout the afternoon but I got tired of counting the trips. It kept on raining intermittently. The number of trips decreased when it drizzled lightly and stopped during heavy shower. The birds stopped work at 5.40 p.m.

On 25th morning I was earlier than the birds. They appeared at 8.45 a.m. each with a long leaf blade and kept on the tempo till I left at 11.00 a.m. In the afternoon I returned at 3.30 p.m. They were still at work. But they were no longer bringing the long and broad leaves of *Urochloa panicoides*, but were bringing the thin stems and long narrow blades of lawn grass. The number of trips had also gone down to 25 an hour (average for 2 hours). Obviously the egg chamber was being lined now. At night at 9 p.m. I checked the nest. One bird flew out. There were no eggs.

On 26th morning when I left for laboratory at 9.45 a.m. the birds were already bringing in the thin stem of lawn grass to which long narrow leaves were attached, but the material being brought was no longer green. It was rather yellow looking and dried up. One of the birds was sitting occasionally in the entrance hole adjusting the nesting material in the egg chamber. On 26th night at 9 a.m. one of the birds was flushed out of the nest. There was also one egg in the nest.

On 27th morning there was hardly any construction work. Between 9 a.m. and 10 a.m. only two trips with nesting material were noticed. By the afternoon the building activity had totally stopped. At night, at 9 p.m. two eggs were noticed in the nest.

WESTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
1182/2, F.C. ROAD,
POONA-5, (MAHARASHTRA),
September 6, 1973.

B. S. LAMBA

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13. A NOTE ON *ENHYDRINA SCHISTOSA* (DAUDIN) (HYDROPHIIDAE: SERPENTES)

On 26-ix-1972 afternoon at about 14 hrs a sea snake, *Enhydrina schistosa* (Daudin), commonly known as 'Valakadyen', was caught at about 5 km off Madras by a fishing nylex net locally known as 'Kavala Valai'. The snake was brought to the laboratory, kept in an aquarium and observations were made.

The snake was restless and kept protruding its head out of water often. Now and then it bit at the sides of the aquarium. It ignored the small fish push into the aquarium as food. This behaviour continued till late in the evening.

On the same night at about 9 p.m. the restlessness and movements of the snake increased and it began biting at the sides of the aquarium ferociously. Then it came to the surface, vomitted two puffer fish one after the other and died a few minutes later. The fishes were identified as *Arothron hypselogenion* (Bleeker), each measuring 90 mm in total length. The fish were partly digested and pale in colour. The snake measured 750 mm and has been preserved in the Museum of this Regional Station.

Sherman (1966) observed three genera of fishes namely, *Tetrodon*, *Coilia* and *Harpodon* in the stomachs of *Enhydrina schistosa* (Daud.)

The fishes belonging to Tetrodontidae are poisonous in general. They are ichthyocrinotoxic, producing their poisons by glandular secretion. Halstead (1970) has compiled an excellent account of the poisons of this group of fishes. He states that the slime of the fish is toxic. Fukuda (1951) found that in a series of 129 cases of puffer poisoning, ten were due to eating the skin of the fish. Day (1878) also has given some account of the effect of the poison of these fishes.

Two probable reasons can be attributed for the death of the snake. The snake may have died due to the effect of toxins produced by the fishes or there might have been some difficulty in swallowing the two fishes and death may have been caused by asphyxiation.

ACKNOWLEDGEMENT

I am thankful to Dr. A. Daniel, O/C, Z.S.I., Madras for providing facilities and giving constant encouragement.

MARINE BIOLOGICAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
Madras-28,
June 28, 1973.

T. VENKATESWARLU

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14. *ECHIS* COLLECTION IN RATNAGIRI DISTRICT

In July 1969 Mr R. Joshi of Deogad (Ratnagiri District) and myself supervised and participated in the collection of over 2,000 live specimens of *Echis carinatus* (Russel) for the venom production laboratory of Haffkine Institute of Bombay.

The Catchers:

A group of tribal people called Mahrs traditionally catch the 'phoorsi' (as they call the saw-scaled viper) in Ratnagiri District but catch no other snakes. They believe that the phoorsi can strike several feet so their catching apparatus consists of long-headed pincers about one metre in length made from bamboo, or may be a blacksmith fashioned forceps. They also carry a stout bamboo staff with an 8 inch spike through one end to serve as a rock turner. The collection basket is plastered with cow dung and has a weighted coconut shell for a secure lid.

The Biotope:

Coastal Ratnagiri District is comprised of rocky (laterite) tableland interspersed with small hillocks of boulders and patches of small forest growth. Most of the year hot and barren, the area literally sprouts life with the arrival of the monsoon (June-September). The tableland becomes slippery from algae and under rocks myriads of amphibians, reptiles and arthropods can be found, urgently feeding and breeding. All of the construction in the area is done with quarried lateriate and in the vicinity of villages most of the loose rocks and boulders are gathered up to form boundary walls. Where the *Echis* go in the hot season is unknown and a subject of much speculation. Dr Vad of Haffkine and myself spent the better part of a day looking for *Echis* in May with no success. *Echis* is the most common reptile besides *Calotes*, its ecology is based on the rock strewn tableland which shelters them as well as their prey.

Echis carinatus ssp.:

This species is found in dry areas from Kenya in Africa to the Jaffna area in Ceylon with wide variation in size, coloration and pattern giving rise to several subspecies the classification of which is being worked upon by investigators such as Stemmler of Switzerland. The Ratnagiri form is a small snake averaging 250-300 mm in length with occasional individuals over 500 mm. It is mainly nocturnal in its habits as very few were collected in the open and of these only one was on the move. Its feeding and breeding habits have been noted by M. A. Smith and other authors, 3 large specimens (over 450) disgorged specimens of the black scorpion *Heterometrus* which measured over 100 mm. Also field mice (*Mus* sp.) were found disgorged in the collection boxes. Juvenile *Echis* were not collected but the ratio of young compared to 200 mm 'adults' was about 1:4. *Echis* exhibit variable temperaments like most snakes, some preferring escape when disturbed and others being very defensive, inflating their bodies and rubbing their body coils to produce the surprisingly loud hissing sound and striking repeatedly at the tormentor.

The Collection:

About 30 Mahrs were engaged for a total of 5 days during which over 2000 *Echis* were collected. 1200 were of the acceptable 200-300 mm length, 600 were over 300 mm and the remainder were under 200 mm. The average price paid to the collectors was 50 paise per snake. The general method was for the Mahrs to scatter in the early morning to their various favoured collection areas and proceed to walk around turning over likely rocks and covering about 15 km during the day. On the first day, collecting alone I found 6 *Echis* under rocks. During the next days, using the experience of the Mahrs, in particular a man named Jamsandekar, my average daily catch was 15 *Echis*, not including babies. The Mahrs have been regularly catching *Echis* for Haffkine's antivenom production for the last 20 years and say that the species is getting noticeably scarcer around Deogad. After some experience one learns which rocks are more likely to be hiding an *Echis* (i.e. those that are not embedded or surrounded by soil and grass). The rock is quickly turned over by hand or stick and the phoorsi, if there, is quickly picked up with the tongs and deposited in the basket (or in some cases an ordinary tin). Some of the snakes are injured by the rough use of these forceps but the risk of bite is reduced to almost zero by this method. Other snakes encountered are either killed or left alone except for *Boiga trigonata* which is also caught and feared as being an extra long *Echis*!

General Notes:

Heavy concentrations of *Echis carinatus* are common in several parts of its range. In Kenya during 2½ months in 1962 and 1963 A. Duff-Mackey and J. Leakey captured 6,933 *Echis.* Wall reports a large population of *Echis* in N.W. India and in 'Ratnagiri District alone rewards were paid on an average of 225,721 Phoorsas per annum', during the late 1800's. Bites from *Echis* in Ratnagiri District and in areas of N.W. India like Punjab and in some parts of the South (around Madras and Trichy) are frequent but fortunately the relatively small size of the central and southern form makes fatal bites extremely rare. However it appears that the larger race in N.W. India and Pakistan is potentially much more dangerous to man.

Other fauna found in conjunction with *Echis* under the thousands of stones we overturned are listed as follows:

SNAKES:

Amphiesma stolatus	—	2	Striped Keelback
Boiga trigonata	—	4	Catsnake
Vipera russellii	—	1	Russell's Viper
Naja naja naja	—	1	Cobra

LIZARDS:

Calotes versicolor	—	many	Garden lizard
Riopa guentheri	—	7	skink
Ophisops beddomei	—	5	skink

Hemidactylus brooki — many
H. maculatus — many
H. frenatus — many
H. albofasciatus — 6

FROGS

Rana hexadactyla
R. tigerina
R. limnocharis
R. cyanophlyctis
R. breviceps ssp.
Microhyla ornata
Rhacophorus maculatus

Caecilian

One species, probably
Indotyphlus—6

ARTHROPODS :

Heterometrus gravimanus — Black scorpion
Buthus tamulus — Red scorpion
Chilopoda — Centipedes (with young)
Diplopoda — Millipedes
Crustacea — Crabs
Arachnida — Spiders
Forficulidae — Earwigs (with young)
Coleoptera — Beetles

Conclusion :

The biotope of Ratnagiri District in the State of Maharashtra is especially interesting for its very high population of *Echis carinatus*. Though an inhospitable area in monsoon it is an extremely valuable study area and worth more attention by herpetologists and entomologists in particular.

MADRAS SNAKE PARK TRUST,
MADRAS-22,
August, 1973.

R. WHITAKER

15. OCCURRENCE OF THE BAT-FISH, *PEGASUS VOLITANS* LINNAEUS (PEGASIFORMES : PEGASIDAE) FROM THE COASTAL WATERS OF INDIA

Day (1889) recorded *Pegasus draconis* Linnaeus from the Andamans; Johnstone (1904) and Munro (1955) recorded *Pegasus* (*Parapegasus*) *natans* (Linnaeus) from the Pearl Banks of Ceylon; and Munro (1955) recorded *Pegasus* (*Parapegasus*) *volans* (Linnaeus) and *Pegasus draconis* Linnaeus from Ceylon. According to Herre (1953) *Pegasus* (*Parapegasus*) *natans* (Linnaeus) and *Pegasus* (*Parapegasus*) *volans* (Linnaeus) are synonymous with *Pegasus volitans* Linnaeus. The family Pegasidae with one genus, *Pegasus* Linnaeus, with probably two degenerate species, *P. volitans* and *P. draconis*, is Indo-Pacific in its distribution, extending from East Africa to Japan and Australia.

Jones & Pantulu (1958) reported a few post-larval stages of *Pegasus* (*Parapegasus*) *volitans* (*natans*) from the Orissa Coast and Krishnamurthy (1961) reported a single larval stage of the same species from the plankton collections off Porto Novo, considered to be the earliest known stage for this species. Since Munro's record from the Gulf of Mannar, there is only one record of an adult specimen of *Pegasus volitans* Linnaeus from coastal waters of India. Jayadev Babu (1966) reported a single specimen of *Pegasus volitans* Linnaeus, off Kovalam, 30 miles south of Madras, the total length of which is only 57 mm.

While going through the fish collections of this Regional Station (Madras), a single specimen of *Pegasus volitans* Linnaeus was found. The specimen was caught off Appa Island, Tamilnadu on 21-i-1969.

The present specimen measures 90 mm in total length which shows that it is the first record of a fully grown specimen from coastal waters of India. The upper surface is dark brown in colour and the lower surface is paler. There are brown spots on the pectoral fins.

The specimen was deposited in the collections of this Regional Station with Reg. No. V. 452.

ACKNOWLEDGEMENTS

My thanks are due to Dr A. Daniel, O/C, S.R.S., Z.S.I., Madras for giving facilities and encouragement, and to Dr A. G. K. Menon, Z.S.I., Calcutta for going through the manuscript critically and for valuable suggestions.

MARINE BIOLOGICAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
MADRAS,
July 24, 1973.

T. VENKATESWARLU

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16. NOTE ON THE RECORD OF GENUS *AMNICOLA* FROM AHMEDABAD

This genus *Amnicola* has two species namely *Amnicola cincta* (Gould) and *Amnicola parvula* (Hutton). *Amnicola cincta* has been recorded from Burma by Gould and *Amnicola parvula* is recorded from northern Afghanistan by Hutton.

The shell is ovately conical and thin. The spire is composed of 4 rounded whorls. The aperture is small, ovately rounded oblique with continuous lips. The colour of the shell is glossy with pearly lustre. As the shell which was collected from Sabarmati river was a very young shell, it was not possible to decide the species and hence a description of genus *Amnicola* is given above.

Habitat: Shell was collected from the sandy bottom of the river bed just near Raj Bhavan.

Specimen in collection:

Measurements: Height: 5 mm, Maximum diameter: 3·5 mm, aperture height: 2 mm, aperture diameter: 1·5 mm.

ACKNOWLEDGEMENT

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BIOLOGY DEPARTMENT,
GUJARAT COLLEGE,
AHMEDABAD-6,
May 15, 1972.

Y. M. DALAL
G. T. PANDYA

17. ADDITION TO THE RECORD OF HOST PLANTS OF *CHILO ZONELLUS* (SWINHOE) (LEPIDOPTERA : PYRALIDAE)

The Jowar stem borer, *Chilo zonellus* (Swinhoe), has been reported as a major pest of Jowar and Maize. It has also been recorded on Sugarcane, Bajra, Rice, Johnson grass, Job's tears (*Coix lachryma-jobi* L.), Kawdia or Burgur (*Polytoca barbata* Stapf) (Trehan & Butani 1949), teosinte (*Euchlaena mexicana*) (Pant *et al.* 1962), Sawa (*Panicum frumentaceum*), Sarkada (*Saccharum sera*), other grasses like *Andropogon* spp., *Eragrostis* spp., *Eleusine verticillata* and *Trianthema monogyna* (Anonymous 1964).

During the year 1971-72, the insect has been found as a minor pest of Wheat at Nelamangala, Chintamani, Hoskote, Kanakapura and

Hebbal in Mysore State. The caterpillar while boring causes dead heart in young plants and chaffy earheads in mature plants.

DIVISION OF ENTOMOLOGY,
UNIVERSITY OF AGRICULTURAL
SCIENCES, HEBBAL,
BANGALORE-24,
June 22, 1972.

M. VISHAKANTAIAH
B. L. VISWESWARA GOWDA

REFERENCES

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18. OCCURRENCE OF PESTS ON KODO MILLET (*PASPALUM SCROBICULATUM*)

The kodo millet is one of the minor crops, cultivated over an area of about 2·42 lakh hectares in Tamil Nadu. The crop is raised during rainy season on poor soils. Generally, the crop is free from any pest or disease.

The crop raised during 1970 at the Millet Breeding Station of the Tamil Nadu Agricultural University was unusually infested with the following new pests.

(*a*) Semi-looper (*Azazia rubricans*)—(Family Noctuideae).

The pest was noticed during the flowering phase of the crop and the caterpillars were feeding on the flowers. The damage to the crop was not however severe since the flowering phase was near completion.

(*b*) Leaf roller (*Cnaphalocrocis medinalis*).

The incidence of this pest was observed in the flowering stage of the crop. The extent of attack on a few varieties of the crop was assessed and the data are presented below:—

No.	Selections	% of attacked plants
1.	PS. 197.	6·8
2.	PS. 192.	7·4
3.	PS. 187.	9·1
4.	PS. 196.	9·7
5.	PS. 175.	13·3

The percentage of attack among the varieties ranged from 6·8 to 13·3.

Based on these preliminary observations, the extent of damage in yield of grains has to be investigated in future.

TAMIL NADU AGRICULTURAL UNIVERSITY,
COIMBATORE-3,
January 6, 1972.

V. D. GURUSWAMY RAJA
U. S. NATARAJAN

19. SYSTEMATICS OF INDIAN RHOPALIDAE (HEMIPTERA)

Earlier workers disagreed upon the rank and the name of this group of insects. It had been considered a subfamily of the family Coreidae under the name Corizinae for several years. Recently, Harris (1942), Schaefer (1965) and Chopra (1967) have pointed out that this group deserves the status of a family and the correct name should be Rhopalidae, Amyot & Serville rather than Corizidae, Douglas & Scott. The Indian representatives of this family have been described and listed by Distant (1902 & 1918) in the subfamily Corizinae. Distant (1902) followed the earlier classification of the group and has indicated that the Indian species belong to two divisions: Corizaria, Stal and Serinetharia, Stal. In 1902 he included four species of a genus *Corizus* in the division Corizaria and six species of the genus *Serinetha* in the division Serinetharia. In 1918 he added six new species to his genus *Corizus* and two additional genera : *Agraphopus* Stal, and *Therapha* Amyot & Serville each containing two species. According to the most recent classification (Chopra 1967) the family is divided into two subfamilies : Rhopalinae, Amyot & Serville and Serinethinae, Stal. The former is considered to be composed of six tribes : Niesthrini, Chopra, Rhopalini, Amyot & Serville, Chorosomini, Douglas & Scott, Harmostini Stal, Maccevithini, Chopra and Corizomorphini, Chopra while the latter included only one group. The Indian species of this family belong to the subfamily Serinethinae and the tribes Niesthrini, Rhopalini and Chorosomini of the subfamily Rhopalinae.

Among Serinethinae, *Leptocoris* Hahn has priority over *Serinetha* Spinola. The species listed by Distant under *Serinetha*, therefore, pertain to *Leptocoris*. Gross (1960) synonymized *dallasi* Dohrn with *augur* F., while Chopra (1971) has described a new species *L. arorai* from south India. The genus *Leptocoris* as recognized now contains nine species and three subspecies from India.

Among the subfamily Rhopalinae, *Corizus* Fallén belongs to the tribe Rhopalini and has priority over *Therapha* Amyot & Serville. The species listed under *Therapha*, therefore, belong to *Corizus*. Kerzhner (1962) synonymized *diluta* Distant with *limbatus* Reuter. The genus *Corizus* is now represented by only one species. The genus *Agraphopus* Stal belongs to the tribe Chorosomini and is represented by one species while the second species *orientalis* (Distant) belongs to the genus *Leptoceraea* Jakovlev. The genus *Corizus* Fallén as considered by Distant, has been divided into several genera. The Indian species listed under *Corizus* actually belong to the genus *Liorhyssus* Stal which is now included in the tribe Niesthrini. Chopra (1967) for the first time recorded the occurrence of *Peliochrous* Stal also of the tribe Niesthrini from south India. Specimens have also been collected from Chandigarh, India.

CHECKLIST OF INDIAN RHOPALIDAE

The descriptions of the species recorded by Distant are mainly based on colour differences which are quite unreliable as the colour of most of the Rhopalid species studied by me vary in a bewildering manner. Until the type specimens are studied further the Indian Rhopalidae are considered to be represented by the following taxa. Some of the species listed below, as indicated, have not actually been reported from India but most probably these will be discovered sooner or later.

Family RHOPALIDAE Amyot & Serville

Subfamily RHOPALINAE Amyot & Serville

Tribe Niesthrini Chopra

Genus *Peliochrous* Stal

Peliochrous Stal, 1873

Type species : *Corizus nigromaculatus* Stal, 1855 ; monobasic.
P. nigromaculatus Stal, 1855, Locality : Chandigarh & South India.

Tribe Rhopalini Amyot & Serville

Genus *Corizus* Fallén

Corizus Fallén, 1814, *Therapha* Amyot & Serville, 1843, *Rhopalus* Spinola, 1837. *Consivius* Distant, 1909.
Type species :—*Corizus* : *Cimex hyoscyami* L., 1758 ; fixed by Brulle, 1835. *Therapha* : *Cimex hyoscyami* L., 1758 ; fixed by Oshanin, 1912, *Consivius* : *Consivius collinus* Distant, 1909=*Cimex hyoscyami* L., 1758 ; monobasic.

C. hyoscyami (L.), 1758. Locality : Simla Hills, Kumaon and Shamkhet.
Therapha diluta Distant, 1918. (Syn. by Kerzhner, 1962).

Genus *Liorhyssus* Stal

Liorhyssus Stal, 1870, *Colobatus* Mulsant & Rey, 1870.

Type species : *Liorhyssus* : *Lygaeus hyalinus* F., 1794 ; fixed by Reuter, 1888. *Colobatus: Corizus gracilis* Herrich-Schaeffer, 1835=*Lygaeus hyalinus* F., 1794 ; monobasic.

L. bengalensis (Dallas) 1852, Locality : North Bengal, Bombay, Bor Ghat & Pusa.
L. brevicollis (Motsch) 1863. Locality : Ceylon.
L. imperialis (Distant) 1918. Locality : Bombay & Dehra Dun.
L. macropictus (Distant) 1918. Locality : Chikkaballapura, Nilgiri Hills & Madras.
L. multimaculatus (Distant) 1918. Locality : Chikkaballapura, South India.
L. parvipictus (Distant) 1918. Locality : Chikkaballapura, South India.
L. pronotalis (Distant) 1918. Locality : Dehra Dun.
L. rubicundus (Signoret) 1859. Locality : Ceylon & Dehra Dun.
L. semicruciatus (Motsch) 1863. Locality : Ceylon.
L. subfasciatus (Distant) 1918. Locality : Ceylon.

Tribe Chorosomini Douglas & Scott

Genus *Agraphopus* Stal

Agraphopus Stal, 1872
Type species : *Agraphopus lethierryi* Stal, 1872 ; monobasic.
A. lethierryi Stal, 1872. Locality : Chikkaballapura, South India.

Genus *Leptoceraea* Jakovlev

Leptoceraea Jakovlev, 1874
Type species : *Leptoceraea viridis* Jakovlev, monobasic.

L. orientalis Distant 1918. Locality : North Bengal & Pusa.

Subfamily SERINETHINAE Stal

Genus *Leptocoris* Hahn

Leptocoris Hahn, 1831. *Serinetha* Spinola, 1837. *Lygaemorphus* Blanchard, 1840. *Pyrrhotes* Westwood, 1842. *Tynotoma* Amyot & Serville 1843. *Boisea* Kirkaldy, 1910.

Type species : *Leptocoris* : *Leptocoris rufus* Hahn, 1831=*Lygaeus abdominalis* F., 1803 ; monobasic. *Tynotoma* : *Tynotoma vittata* Amyot & Serville, 1843 ; monobasic (nomen dubium). *Boisea* : *Boisea vittata* Kirkaldy, 1910=*Leptocoris trivittatus* Say, 1825 ; monobasic.

L abdominalis (F.) 1803. Locality : Calcutta & Assam.
L. abdominalis abdominalis (F.) 1803.
L. abdominalis blötei Gross 1960.
L. abdominalis taprobanensis (Dallas) 1852.
L. arorai Chopra 1971. Locality : Nilgiri and south Malabar Hills.
L. augur (F.) 1781. Locality : Bombay, Calcutta & Madras.

L. dallasi (Dohorn) 1860. (Syn. by Gross, 1960).

L. coimbatorensis Gross 1960. Locality : Coimbatore.
L. corniculata (Stal) 1866. Locality : Western India.
L. coxalis (Kirby) 1891. Locality : Ceylon.
L. rufomarginata (F.) 1794. Locality : Calcutta & Nicobar Islands.
L. subrufescens (Kirby) 1888. Locality : Ceylon and Christmas Island.
L. vicina (Dallas) 1852. Locality : Ceylon.

DEPARTMENT OF ENTOMOLOGY,
HARYANA AGRICULTURAL UNIVERSITY,
HISSAR,
August 18, 1972.

N. P. CHOPRA

REFERENCES

(NOTE: All references prior to 1967 are listed by Chopra, 1967 and Distant, 1902 & 1918.).

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20. DISTRIBUTIONAL RECORDS OF MUSCIDAE (DIPTERA)

Muscidae (Diptera) contains probably the world's commonest and most ubiquitous insects, the adults of which transmit several dangerous and widespread diseases including typhoid fever, several kinds of dysentery, cholera and trachoma while a few members of the family have been listed as parasitic in nature. The following muscids were collected at Damoh, Madhya Pradesh and Mirzapur, Uttar Pradesh.

Species		Date of collection
Atherigona sp.? *bella* Frey	..	14-vii-1966
Dichaetomyia nubiana Bigot	..	26-vii-1967
Fannia leucosticta Mg.	..	28-xii-1966
Gymnodia tonitrui Wied.	..	9-vi-1966
Helina nervosa Stein	..	11-viii-1967
Limnophora himalayensis Brun.	..	3-vii-1967
Lispe leucospila Wied.	..	24-vii-1966
Musca domestica L.	..	2-viii-1966
M. illingworthi Patton	..	9-ix-1963
M. pattoni Aust.	..	2-vii-1966
M. ventrosa Wied.	..	9-ix-1963
Ophyra sp.	..	19-iii-1966
Orthellia sp.	..	12-viii-1967
Orchisia costata Mg.	..	18-viii-1967
Paregle cinerella Fall.	..	11-vi-1966
Passeromyia heterochaeta Vill.	..	14-ix-1966
Pegomya sp.	..	16-viii-1966
Stomoxys calcitrans L.	..	16-ii-1967
Synthesiomyia nudiseta Wulp.	..	14-iii-1966

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INDIAN LAC RESEARCH INSTITUTE, R. S. GOKULPURE
NAMKUM, RANCHI,
October 15, 1971.

21. SHEPHERD'S PURSE—AN EDIBLE PLANT OF KASHMIR

Shepherd's purse—*Capsella bursa-pastoris* Moench is a widely distributed plant growing throughout temperate regions of India. It is reported to have a wide medicinal application which includes its use as a diuretic and as a deterrent for haemorrhage (WEALTH OF INDIA, II, 68, 1950). There is however no record of its use for edible purposes. In the course of our search for little known edible plants of the North-Western Himalayas we found people in district Doda of Jammu and many parts of Kashmir valley using this plant as a favourite vegetable. At Sanasar in Doda District the plant is known as 'Drati' and in Kashmir province it is called as 'Kral mund'. The leaves and tender flowering shoots of the plant are cooked into a slightly sour dish.

Rosettes of *Capsella bursa-pastoris* appear immediately after the snow melts. At this time of the year, very few plants are available for human consumption in the mountainous areas. The locals largely depend upon sun-dried vegetables of the previous season. Shepherd's purse, therefore, provides a good change. The children also eat the raw fruits.

Capsella bursa-pastoris Moench belongs to the mustard family (Cruciferae) and is an erect annual with a rosette of deeply clefted leaves oppressed to the ground. Flowering shoots are about 40 cm long and bear small white flowers and conspicuous heart-shared fruits (to which the plant owes its common English name). The fruits dehisce longitudinally along the central septum exposing two rows of minute seeds on each side.

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DEPARTMENT OF BIO-SCIENCES, A. K. KOUL
UNIVERSITY OF JAMMU, J. L. KARIHALOO
JAMMU,
August 11, 1973.

22. TAXONOMICAL NOTES ON *CLEOME ASPERA* KOEN. EX DC., *C. BURMANNI* WT. & ARN. AND *C. RUTIDOSPERMA* DC. (CLEOMACEAE)

Iltis (Brittonia 12: 290, 1960) included *C. aspera* Koen. ex DC., *C. burmanni* Wt. & Arn. and *C. rutidosperma* DC., together with *C. micrantha* (Boj.) Baker of Madagascar, under the section *Rutidosperma* Iltis because of their close affinity. The close alliance of *C. burmanni* Wt. & Arn. with *C. rutidosperma* DC. (= *C. ciliata* Schum. & Thonn.) is also evident from the remark of Hooker f. & Thomson (Fl. Brit. Ind. 1: 170, 1872) who commented that the former resembles the latter which is a native of tropical Africa, now introduced elsewhere. Dixit & Siddiqui (Ind. For. Ined.) had gone to the extent of reducing *C. burmanni* Wt. & Arn.—a peninsular Indian and Ceylonese species, to the synonymy of *C. rutidosperma* DC.—an African alien.

C. aspera Koen. ex DC.—another Peninsular Indian and Ceylonese species, is also closely allied to *C. burmanni* Wt. & Arn. It is this species that is often mixed and confused with *C. burmanni* Wt. & Arn. As is evident from the description as well as from the annotated specimens by Jacob, the Malaysian plants which were hitherto referred to as *C. aspera* actually belong to *C. burmanni* (vide Jacob, Fl. Males.: Ser. 1, 6: 105, 1960; Backer & Bakh. f., Fl. Java 1: 183, 1963). However, it is true that *C. burmanni* is very much similar to *C. rutidosperma* in its vegetative features, but is remarkably distinct from *C. aspera* in certain vegetative and floral characters. These three related taxa can be distinguished in the following manner:

1. Pod sessile. Leaflets oblong-lanceolate, clothed with tubercle-based setose hairs; petioles shorter than leaflets, 0·5-1·5 cm long .... *C. aspera*

1. Pod distinctly stalked (on gynophore). Leaflets ovate, elliptic, rhomboid or obovate, glabrous except softly setose nerves; petioles as long as or longer than leaflets. 2

2. Pod terete, torulose, 0·15-0·2 cm across. Petals 0·5-0·7 cm long. Stems thinly clothed with persistent short, compressed, hooked or recurved prickly appendages, 0·03-0·05 cm long; seeds with a closed cleft, without elaiosomes .... *C. burmanni*

2. Pod compressed, 0·4 cm across. Petals 0·8-1 (-1·2) cm long. Stems clothed with deciduous or subpersistent, linear, recurved, soft appendages, 0·05-0·2 cm long. Seeds with a closed cleft, with white elaiosomes .... *C. rutidosperma*

Cleome aspera Koen. ex DC. Prodr. 1: 241, 1824; Wt. & Arn. Prodr. 22, 1834; Wt. Icon. t. 287, 1840. Hook. f. & Thoms. in Fl. Brit. Ind. 1: 169, 1872; Gamble, Fl. Presid. Madras 40-41, 1915. Trimen, Handb. Fl. Ceyl. 1: 56, 1893; Pax & Hoffm. in Pflanzenfam. ed. 2. 17б: 214, 1936.—*C. diffusa* Roxb. Fl. Ind. 3: 129, 1832.

Prostrate or decumbent-ascending, multicauline, annual herbs. Stems simple or sparsely branched at base, ribbed, clothed with short compressed, hooked prickly appendages. Leaves 3-foliolate, rarely, higher ones 1-foliolate, lower ones long-petioled, upper ones short-petioled or subsessile, becoming smaller upwards: petioles 0·2-1·5 cm long; leaflets subsessile, oblong-lanceolate, subobtuse, tipped with a bristle, with ciliate, recurved margins, scabridly hairy with tubercle-based hairs, 0·5-2·5×0·2-0·5 cm. Flowers solitary, in axils of higher leaves often forming leafy racemes; pedicels 0·3-0·5 cm long, glabrate or short hairy; sepals linear-lanceolate, 0·05 cm long; petals white, oblanceolate, 0·25-0·3 cm long; stamens 6, 0·25 cm long; ovary sessile, style linear, 0·02 cm long. Fruit sessile, terete, torulose, narrowed at both ends, 1·5-3 cm long (incl. beak), glabrous, 0·15-0·2 cm across; seeds reddish brown, with prominent cross-ribs and concentric ribs, 0·15-0·17 cm across.

Type: *Koenig* (K)

Flowers and fruits: July-Oct.

Specimens examined: INDIA: Coimbatore, Bolampatti valley, alt. 500 m, *Fischer* 2038 (CAL). Nellore, Velikonda Hills, *Ramaswamy* 1352 (CAL); without definite locality, *Cleghorn*, s. n. (CAL)

Distribution: Peninsular India and Ceylon.

Cleome burmanni Wt. & Arn. Prodr. 22, 1834; Hook. f. & Thoms. in Fl. Brit. Ind. 1: 170, 1872; Gamble, Fl. Presid. Madras 40-41, 1915; Pax & Hoffm. in Pflanzenfam. ed. 2. 176: 214, 1936.

C. aspera sensu Jacobs in Fl. Males. Ser. 1·6: 105, 1960; Backer & Bakh. f. Fl. Java 1: 183. 1963 (non Koen. ex DC.).

Erect, widely branched annual herbs. Stems ribbed, thinly clothed with short compressed, prickly appendages, 0·03 cm long. Leaves 3-foliolate, lower ones on longer petioles, higher ones short-petioled or subsessile, upwards reduced; petioles 0·15-2·5 (-3) cm long; leaflets subsessile or short petioled, elliptic-lanceolate or oval-lanceolate, narrowed at both ends, acute or subobtuse at apex, slightly oblique, cuneate or acute at base, membranous, laxly, faintly crenulate-serrate, ciliate, glabrous except setosely hairy nerves, 1-3 × 0·4-1 cm. Flowers solitary, in axils of higher reduced leaves ; pedicels slender, short-gland-hairy, 0·5-1·5 (-2) cm long ; sepals lanceolate, acuminate, 0·1-0·15 (2) cm long ; petals 0·4-0·5 cm long ; stamens 6, 0·5 cm long ; ovary on a 0·2 cm long gynophore. Fruit terete, torulose, glabrous, attenuate at both ends, on 0·4-0·6 cm long gynophore, 3-5 cm long (incl. 0·02-0·03 cm long beak), 0·15-0·2 cm across ; valves parallel-nerved ; seeds reddish-brown, 0·1 cm across with concentric and cross ribs, with a closed cleft and without a elaiosome.

Type : *Wight* 75 (K-holotype ; CAL-isotype)

Specimens examined : INDIA : Without definite locality, *Wight* 75 (CAL-isotype). CEYLON : Without definite locality, *Thwaites* 1068 (CAL). INDONESIA : Java Madioen Zeehooghe 65 H, *Backer* 6911 (CAL).

Distribution : Western Peninsular India, Ceylon and Java.

Cleome rutidosperma DC. Prodr. 1 : 241, 1824 ; Iltis in Brittonia 12 : 290, 1960 ; Jacobs in Fl. Males. Ser. 1. 6 : 105, 1960 ; Backer & Bakh. f. Fl. Java 1 : 183, 1963.

C. ciliata Schum. & Thonn. Dansk. Vid. Selsk. Afgh. 4 : 67, 1827 ; Pax & Hoffm. in Pflanzenfam. ed. 2. 17b : 213, 1936 ; Johnson & Tan. in Gard. Bull. Sing. 17 : 325-330, 1959.

Erect or decumbent-ascending, usually widely branched, annual herbs, 15-100 cm tall. Stems ribbed, clothed with soft, linear, recurved, deciduous, 0·05-0·2 cm long, prickly appendages. Leaves 3-foliolate, lower ones long-petioled, higher ones short-petioled or sessile, upwards reduced ; petiole 0·3-0·5 cm long ; leaflets subsessile or short-petioled, elliptic-rhomboid or elliptic-lanceolate-oblong, with a cuneate or acute, narrowed base, subacute, often narrowed to the top, ciliate ; serrulate, often purple margined, glabrous except softly setose hairy nerves, 0·5-3 × 0·3-1·5 cm. Flowers solitary, in highest leaf axils ; pedicels 1-1·4 cm long during anthesis, 2-2·5 (-3) cm long in fruiting, short-gland-hairy ; sepals lanceolate, acuminate, 0·25-0·4 cm long ; petals obovate-elliptic, 0·9-1 (-1·2) cm long ; stamens 0·8-1 cm long ; ovary on 0·15-0·2 cm long gynophore, stigma sessile. Fruit compressed on 0·5-1 cm long gynophore, attenuate at both ends, glabrous, 4-7 (incl. 0·1-0·2 cm long beak) cm long, 0·3-0·4 cm across ; seeds suborbicular reniform, dark-brown, with an open cleft and a white elaiosome (aril), with prominent concentric and cross ribs.

Type : Without Collector's name (*Smeathman*) (*G-DEL*)

Flowers and fruits : Greater part of the year.

Specimens examined : INDIA : West Bengal. Calcutta, Lady Brabourne College Compound, *Chandra*, (CAL). SINGAPORE : Chury Road, Tangli, *Furtado* 2117 (CAL).

Distribution : A native of tropical Africa, adventive in New World, introduced in the Caribbean region, found in Malaysia, collected in Burma and is now recorded here from India.

In his extensive discussion on the typification and identification of *C. rutidosperma* DC., Iltis (loc. cit.) showed that *C. ciliata* Schum. & Thonn. is conspecific with *C. rutidosperma* DC., which was hitherto considered as an enigmatic species, and is the correct name for this widely spreading tropical African alien, as it has got priority over *C. ciliata* Schum. & Thonn.

ACKNOWLEDGEMENT

Grateful thanks are due to Dr M. P. Nayar, Keeper, Central National Herbarium, Calcutta, for his encouragement and suggestions.

CENTRAL NATIONAL HERBARIUM,
HOWRAH,
September 8, 1973.

C. R. BABU[1]

N. C. MAJUMDAR[2]

23. A NEW SPECIES OF *SONERILA* (MELASTOMATACEAE) FROM KERALA, S. INDIA

(*With a plate*)

Sonerila devicolamensis sp. nov.

Affinis *S. sadasivanii* Nayar, sed caulibus infra subangularibus, supra teretibus, crassibus, rubicundibus, conspicue cicatribus, carnosis, foliorum marginibus conspicue serratis, inflorescentias robustis carnosisque, floribus majoribus differt.

Herba suberecta, caulibus infra subangularibus, radicantibus, supra teretibus, rubicundibus, cicatribus, crassibus carnosisque. *Folia* opposita, ovata vel ovato-elliptica, 3-6 × 1·5-3 cm, basi obtusa vel anguste cuneata, apice acuta, margine e basi ad apicem conspicue serrata, supra subterque glabra, 5-nervia, nervis ex apice petioli ortis, venulis transversis absenti-

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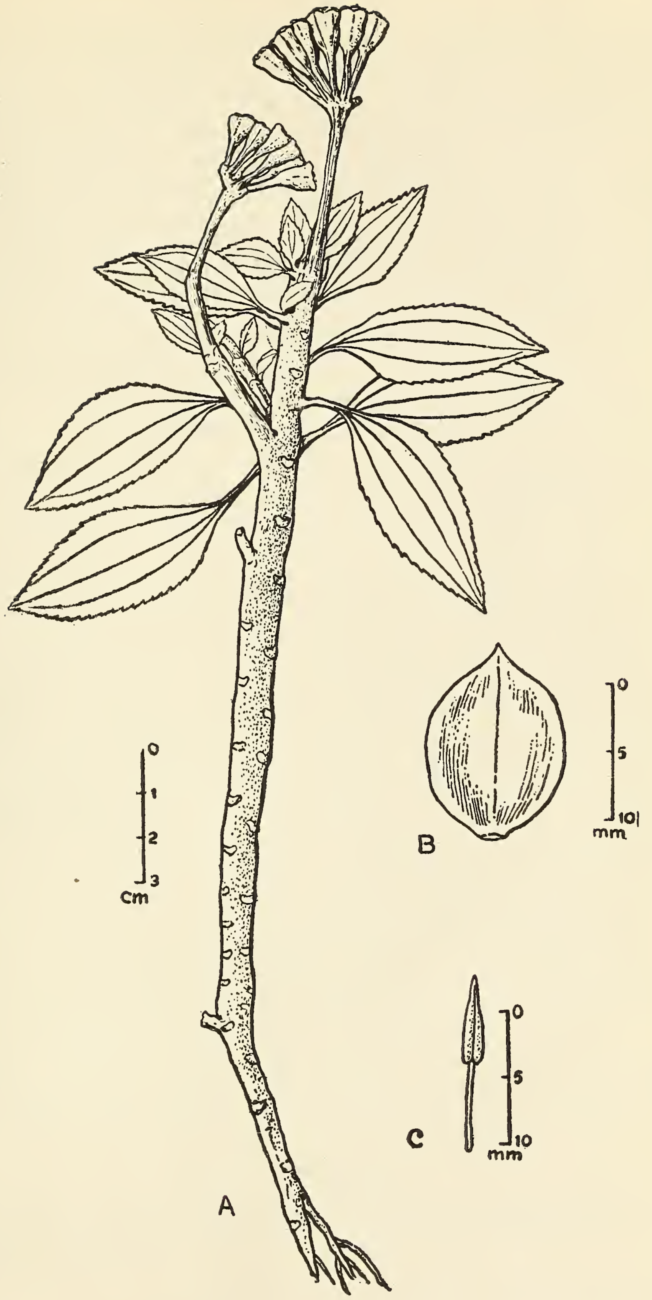
[1] *Present address* : Department of Botany, University of Delhi, Delhi-7.
[2] *Present address* : Botanical Survey of India, Shillong-3.


A
B
C
0
1
2
3
cm
0
5
10
mm
0
5
10
mm

Sonerila devicolamensis sp. nov.

A. Habit—natural size. B. Petal. C. Stamen.

[illegible] [illegible]

bus. *Petioli* 1-2·5 cm longi, crassi, rubicundi. *Inflorescentia* terminalis vel axillaris, 4-8 cm longa, glabra 5-12 flora ; pedunculus 3-4 cm longus, glaber, rubicundus ; pedicelli 4-8 mm longi. Calycistibus campanulatus, 7-10 mm longus, glaber, rubicundus ; limbus 3-lobatus, lobibus triangularibus 2·5-3 mm longis. *Petala* 3, ovato-elliptica, 1·3-1·5×1-1·2 cm, apice apiculata, rosea. *Stamina* 3, filamentis 6-7 mm longis, antheris 5·5-6 mm longis, basi cordatis, connectivo, inappendiculato. *Stylus* filiformis, 1·2-1·3 cm longus, glaber, stigmate punctiformi. *Capsula* obconica, 1-1·5 cm longa, glabra ; pedicellus 1-1·3 cm longus. *Semina* cuneata, 1 mm longa, numerosa.

Typus : *A. Meebold* 13771 (CAL).

Sonerila devicolamensis sp. nov.

Allied to *Sonerila sadasivanii* Nayar, but differs in having the lower portion of the stem subangular, and upper portion of stem terete, thick, fleshy, reddish and conspicuously marked with leaf scars, leaf margin conspicuously serrate, inflorescence robust fleshy, and flowers larger.

Suberect herb ; stem in the lower portions subangular rooting at the nodes, upper portion terete, reddish conspicuous with leaf scars thick and fleshy. Leaves opposite, ovate or ovate-elliptic, 3-6 × 1·5-3 cm, base obtuse or narrowly cuneate, apex acute, leaf margin from base to apex conspicuously serrate, upper and lower surfaces glabrous, 5-nerved, nerves arising from the apex of the petiole, transverse venules absent ; petiole 1-2·5 cm long, thick and reddish. Inflorescence terminal or axillary, 4-8 cm long, glabrous, reddish, pedicel 4-8 mm long. Calyx tube campanulate, 7-10 mm long, glabrous, reddish ; limb 3-lobed, lobes triangular, 2·5-3 mm long. Petals 3, ovate-elliptic, 1·3-1·5 × 1-1·2 cm, apex apiculate, pink. Stamens 3, filament 6-7 mm long, anther 5·5-6 mm long, base cordate, connective, inappendiculate. Style filiform, 1·2-1·3 cm long, glabrous, stigma punctiform. Capsule obconical 1-1·5 cm long, glabrous ; pedicel 1-1·3 cm long. Seeds cuneate, 1 mm long, numerous.

Distribution : INDIA : Kerala, Devicolam, *A. Meebold* 13771 (Holotype CAL) ; ibid. ; alt : 2000m., Dec. 1910, *A. Meebold* 13893, (CAL).

ACKNOWLEDGEMENT

I am thankful to Dr K. Subramanyam, Director, Botanical Survey of India for encouragement.

KEEPER, M. P. NAYAR
CENTRAL NATIONAL HERBARIUM,
BOTANIC GARDEN P. O.,
HOWRAH-3,
May 5, 1973.

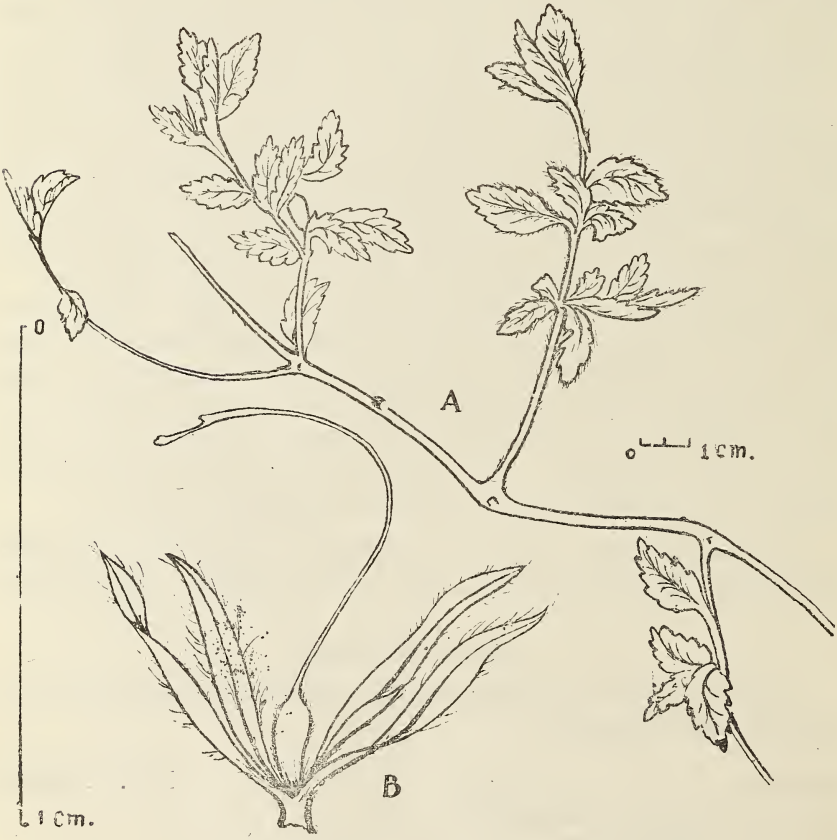
24. *HEMIGRAPHIS HIRTA* (VAHL) T. ANDERS.—A NEW RECORD FOR BOMBAY

(*With a text-figure*)

The author in his rambles in the ravines of Por (Dist. Baroda) has come across *Hemigraphis hirta* which is not listed in Th. Cooke's (1904) Flora of the Presidency of Bombay. H. Santapau (1952) did not record it in his monographic work—' The Acanthaceae of Bombay ' and in Journ. Bombay nat. Hist. Soc. 51 : 349-68, 1953.

Hemigraphis hirta (Vahl) T. Anders. in Journ. Linn. Soc. 9 : 462, 1867 ; Clarke in Hooker's Fl. Brit. Ind. 4 : 422, 1884.

Ruellia hirta Vahl, Symb. Bot. 3 : 84, t. 67, 1794 ; Roxb. Fl. Ind. 3 : 46, 1832 ; Nees in DC. Prodr. II : 145, 1847, excl. var. β.



Hemigraphis hirta (Vahl) T. Anders.
A. Part of the plant.
B. Flower.

R. latebrosa Roxb. Fl. Ind. 3 : 46 ?, 1832 ; Wall, Cat. 2382, *not of* Roth *nor of* Dalz. *nor of* Wight.

R. sarmentosa Nees in Wall. Pl. As. Rar. 3 : 83, 1832.

Soft, pubescent herbs ; villous with white hairs. Stems creeping, flexuose. Leaves small, ovate, crenate. Flowers in small, close terminal heads ; pale blue in colour ; corolla long-cylindric below, upper part funnel-shaped ventricose ; bracts elliptic, bracteoles O ; calyx-lobes linear, obtuse, green. Capsule linear-obovoid, glabrous except at tip, about 12-seeded.

Flowering and *Fruiting* : April.

INDEX KEWENSIS gives India as the home of this plant. The species is confined to India and occupies a rather isolated position in the genus *Hemigraphis* Nees.

The species has not been recorded from Bombay.

ACKNOWLEDGEMENTS

The identification was checked in Netherlands by Professor Dr C. E. B. Bremekamp, to whom I tender sincere thanks.

GENERAL EDUCATION CENTRE, G. M. OZA
MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA,
BARODA 2,
September 2, 1973.

25. HERMAPHRODITISM IN CASSAVA (*MANIHOT ESCULENTA* CRANTZ.)

(*With two photographs & nine text-figures*)

Cassava (*Manihot esculenta*) is an important food crop, extensively cultivated in the tropics for its tuberous roots which contain starch. Kerala is the chief cassava-growing State in India.

A large collection of germplasm consisting of about 400 varieties of this monoecious species is maintained in the Department of Botany, University of Kerala, Trivandrum. During the course of extensive studies on cassava germplasm, hermaphrodite flowers have been observed in one strain of cassava namely H. 450 (Accession No. M. 67-48). The present paper deals with detailed observations on hermaphroditism in this species, which is being recorded for the first time.

OBSERVATIONS

As has been described by earlier workers (Rendle 1925 ; Panicker 1957), flowers in *Manihot esculenta* are hypogynous, actinomorphic and are borne in terminal compound cymose panicles. The female flowers are fewer in number compared to male flowers, usually occur at the basal part of the panicles and open first. After a week or so, the male flowers, produced in large numbers in terminal clusters, begin to open one by one in acropetal succession. This difference in maturity of the male and female flowers ensures cross pollination in nature and consequently the plants are highly heterozygous.

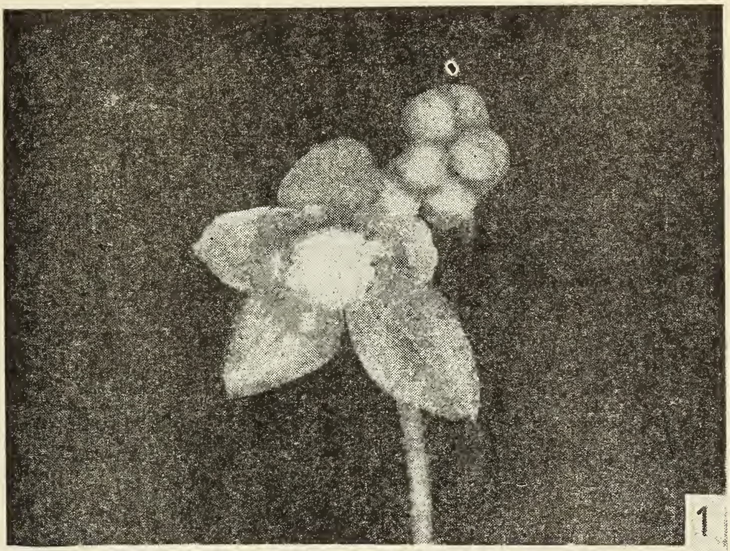
Unisexual Flowers

The majority of the flowers produced in H. 450 are unisexual. Pistillate flowers are larger than the staminate flowers and have five free perianth segments and a tricarpellary, syncarpous superior ovary on an annual slightly lobed prominent disc. In the staminate flower, the perianth is cup-shaped, five lobed above, with ten stamens in two whorls of five each.

Hermaphrodite Flowers

Hermaphrodite flowers having five free perianth lobes (Photo 1 and Text-fig. A) and those with fused cup-shaped perianth (Photo 2 and Text-fig. G) have been found in this variety. The hermaphrodite flowers with free perianth lobes resemble the female flowers in external appearance, the only difference being the presence of stamens in them. They are seen below the male flowers in the cymose panicle. Each flower has five free triangular perianth segments with obtuse apex (Text-figs. A & B). The perianth segments are imbricate in bud (Text-fig. F) and white in colour with greenish tint on the outside. The majority of the flowers have 10 stamens, but the number has been found to vary from 1-10 in many cases. When there are 10 stamens, they are arranged in two whorls of five each. The outer stamens have long filaments and are seen opposite the perianth lobes (Text-figs. C & D). The inner five have short filaments and alternate with the first whorl. Anthers dehisce longitudinally, those of the outer whorl introse and inner, extrose (Text-figs. D & F). About 93 % of the pollen are fertile. The pistil is tricarpellary, syncarpous with superior ovary on an annular, slightly ten lobed, prominent disc (Text-fig. E). The ovary is broadly oblong, distinctly six ridged and three chambered with a solitary, pendulous, anatropous ovule in each chamber (Text-figs. B & F). The stigma is almost sessile, trifid, sticky and white in colour and each stigmatic branch divides repeatedly into many fine closely packed lobes.

A second type of hermaphrodite flower with cup-shaped perianth like the normal staminate flowers also occurs in these plants. They open along with the pistillate flowers, earlier than the staminate flowers. The perianth is cup-shaped with five distinct lobes at the top and the cleavages extend almost to the middle of the cup (Text-fig. G). The fused basal part of the perianth is slightly ribbed outside. The perianth lobes are white with a slightly reddish tint and imbricate in bud (Text-fig. 1).



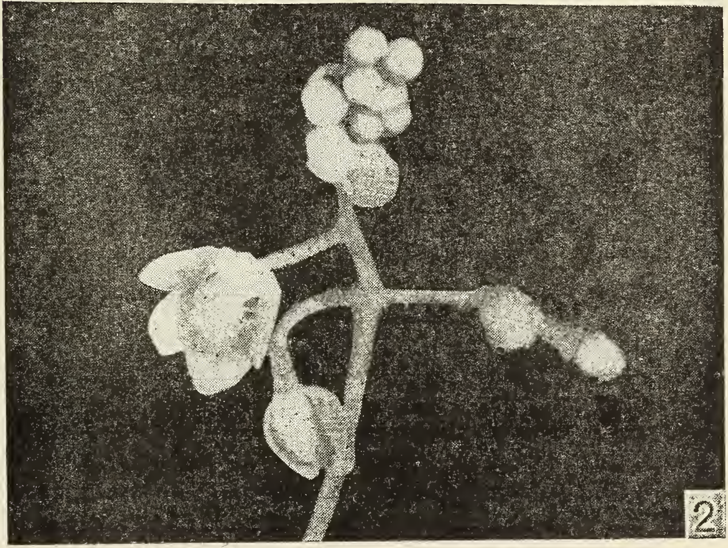
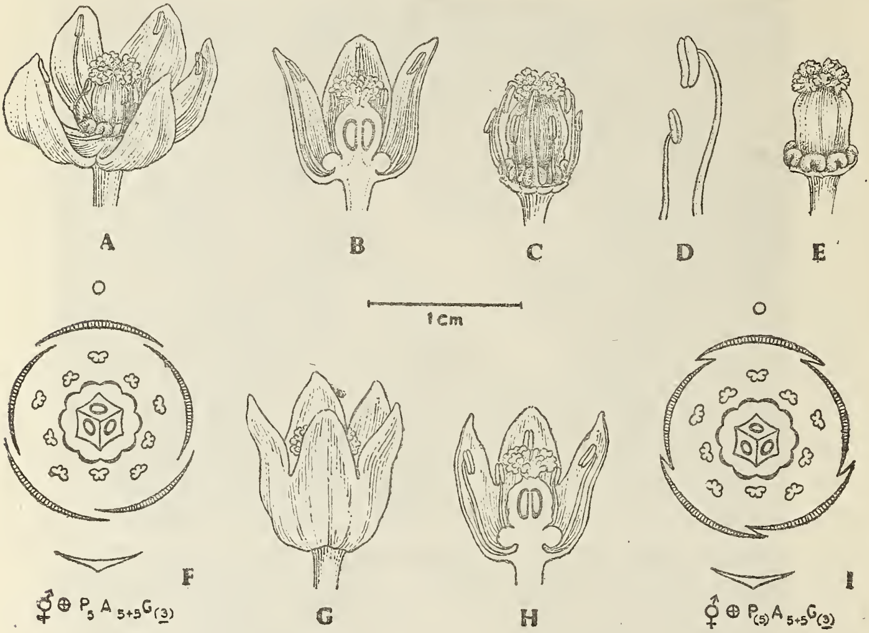


Fig. 1. A portion of an inflorescence showing a hermaphrodite flower with free perianth lobes.

Fig. 2. Hermaphrodite flower having cup-shaped perianth.

The number and arrangement of the stamens are similar to those of the normal male flowers (Text-figs. H & I). The pistil is usually well developed, but rarely poorly developed. About 94% of the pollen are fertile.



Figures A-F—Details of hermaphrodite flowers having free perianth lobes and G-I—flowers having fused perianth. A : whole flower. B : L.S. of flower. C : flower, after removal of perianth lobes. D : stamens having long and short filaments. E : Gynoecium. F : floral diagram. G : whole flower. H : L.S. of flower. I : floral diagram.

DISCUSSION

Hermaphrodite flowers do not appear to have been recorded so far in *Manihot esculenta*. There are reports of the occurrence of hermaphrodite flowers in coconut, cucurbits and papaya, which like *M. esculenta* usually produce unisexual flowers. Gopala Rao (1948) observed a stray instance of hermaphrodite flowers in coconut and Davis, Anandan & Menon (1954) have reported the occurrence of hermaphrodite trees in coconut. In cultivated cucurbits where hermaphrodite female and male plants occur, genetic studies have indicated that the development of stamens and pistil is suppressed by two dominant genes 'A' and 'G' respectively, the recessive alleles of which in the homozygous conditions promotes development of plants with perfect flowers (Whitaker & Davis 1962). Papaya plants with hermaphrodite flowers are also known to be homozygous recessive (mm), the two dominant alleles M_1 and M_2 in heterozygous condition (M_1m and M_2m) resulting in male and female plants respectively (Storey 1953; Hofmeyer 1953). Plants having exclusively hermaphrodite flowers have not so far been encountered in *Manihot esculenta.* However, the regular occurrence of hermaphrodite flowers in all the ten plants in the variety H. 450 indicates that this phenomenon is possibly genetically controlled.

ACKNOWLEDGEMENTS

This study has been made possible through the efforts of Prof. A. Abraham, University of Kerala (now in the F.A.O.) who had assembled a large collection of germplasm of root and tuber crops in this Department. The material studied by us is a hybrid evolved by him. We are grateful to him for access to this material. We are also thankful to the United States Department of Agriculture for a generous grant which enabled us to maintain and make further studies on this collection.

DEPARTMENT OF BOTANY,
UNIVERSITY OF KERALA,
TRIVANDRUM,
September 29, 1973.

PHILOMENA MADHAVADIAN
SUSAN ABRAHAM
C. A. NINAN

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ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1973-74

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HONORARY SECRETARY'S REPORT FOR THE YEAR 1973

MEMBERSHIP

The membership position continues to be unsatisfactory. The main source of income for the Society should be the Ordinary Members. The number of ' paid up ' members on the Society's register as on the 1st January of the years 1971 to 1974 is given below :

	1971	1972	1973	1974
Ordinary Members	703	780	801	770

The Society's activities during the year under report have resulted in a deficit of Rs. 30,090 which is equivalent to the subscription of an additional 858 ordinary members at the current rate of subscription. We would request members to assist the Society by recruiting more members. The current income from membership subscription hardly covers the cost of printing three issues of the *Journal.*

The number of other classes of members are given below :

	1971	1972	1973	1974
Life Members	174	181	187	198
Student Members	5	5	9	16
Honorary ,,	3	3	3	3
Forest Department Nominees	78	80	89	90

ACTIVITIES

PUBLICATIONS

Journal : Only two issues of the *Journal* were published during the year Vol.69 No.3 & Vol. 70 No.1. We continue to be plagued by the inability of the press to keep to publication dates and in 1973 there was unfortunately a very severe power cut upsetting all production schedules. We hope to give a better account in 1974.

The articles continued to cover a wide range of subjects with emphasis on the ecology, behaviour, and taxonomy of Indian fauna and the taxonomy and regional lists of Indian flora.

We are making progress in the preparation and publication of the *Journal* indexes. 8 indexes have been published so far (including a General Index of subjects and authors for Vols. 43 to 53) at a total cost of Rs. 19,341.45 (1968-73). Six indexes are still pending publication.

Books : During the year the following sales were made :

	Sale	*Balance Stock*
BOOK OF INDIAN BIRDS	1,861	3,719
BOOK OF INDIAN ANIMALS	792	2,695
SNAKE CHARTS	64	974
PICTURE POSTCARDS	161	87
CHECKLIST OF THE BIRDS OF MAHARASHTRA	251	717
GLIMPSES OF NATURE IN INDIA	208	3,568

We are continuing our efforts to obtain financial assistance for reprinting our out-of-print books on Natural History, particularly SOME BEAUTIFUL INDIAN TREES, SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS, BUTTERFLIES OF THE INDIAN REGION, CIRCUMVENTING THE MAHSEER AND OTHER SPORTING FISH, and INDIAN MOLLUSCS.

We are glad to report that 9 volumes of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Sálim Ali & Dillon Ripley, sponsored by the Society and published by Oxford University Press, are now available. The 10th volume of this definitive treatise on birds of the Indian subcontinent is expected to be published in 1974.

The publication costs of the CHECKLIST OF THE BIRDS OF MAHARASHTRA were borne by the author, Mr Humayun Abdulali and the sale proceeds after adjusting publication costs will be credited to the Charles McCann Field Work Fund. We are grateful to Mr Abdulali for this generous arrangement. The CHECKLIST is an invaluable aid to birdwatchers in Maharashtra.

Mr Krishnan's excellent photographs and supporting text on the mammals of peninsular India, INDIA'S WILDLIFE 1959-70 will be available in book form in 1974. We are grateful to the Seth Purushottamdas Thakordas & Diwaliba Charitable Trust for the financial assistance which made this publication possible.

The Society's Nature Calendar continues to be popular and a source of income.

CONSERVATION

The Society continued to take a leading part in the Conservation Movement in the country through its representatives on the State and Central Wild Life Boards, and through its members on the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund, and the International Council for Bird Preservation. Conservation oriented field studies were made by the Society's staff in various parts of the country on specific projects.

RESEARCH AND FIELD STUDIES

Bhutan Bird Survey. A party from the Society led by Dr Sálim Ali spent seven weeks in Bhutan, collecting specimens and observing birds at various elevations. Interesting collections include the rare Indian Honeyguide, a bird not so far represented in the Society's collection. Dr Sálim Ali is at the moment engaged in the preparation of a field guide to the birds of the Eastern Himalayas.

Saltwater Crocodile Survey. The Curator led a party to the Bhitarkanika Island in Orissa to study the status of the crocodiles living in the area. The report on the survey was sent to the crocodile Specialist Group of the IUCN. The survey was financed by the World Wildlife Fund—Indian National Appeal.

Gir Forest. Mr R. B. Grubh, Senior Research Assistant, visited the Gir to report on the effect of drought on the Wildlife, particularly the lions. The trips was financed from the Dorabji Tata Trust Fieldwork Fund.

Sálim Ali/Loke Wan Tho Ornithological Research Fund. The Fund continued to support with a fellowship, the research of Mr V. S. Vijayan who is investigating the ecological isloation of two sympatric species of bulbuls in the Point Calimere Sanctuary in Tamil Nadu.

Nilgiri Tahr Survey. Mr E. R. C. Davidar, a member at Coonoor, Nilgiris, was given a grant from the Fauna Preservation Society's Indian Membership Funds for surveying the status of the Tahr in the hills of South India. A report has been received.

Leopard Study. Efforts were continued by a small group of Bombay members to obtain information about, and to draw to baits, leopards living in the Borivli National Park near Bombay. Leopards were seen on several occasions in drives along the Park road but no baits were taken. It is planned to continue the work in a slightly different manner in 1974. The study group was supported by a grant received from the Fauna Preservation Society's Indian Membership Funds.

Nature Walks. Nature Walks were organised in Borivli National Park for birdwatching and for study of the vegetation during almost all the months of the year. The field activities were financed from the Col. Burton Fieldwork Fund.

Bird Migration. The activities during the year were supported by grants from the Ministry of Agriculture, Government of India. The emphasis of the studies was more on bird populations than purely on migratory phenomena. Camps were held at Bharatpur (Rajasthan) Borivli (Bombay), and Daulatabad (Maharashtra).

During the year we received information of the recovery in Russia of 176 of our ringed birds. Other interesting recoveries were of flamingos ringed in Iran and recovered near Delhi, Rajasthan, Gujarat, Hyderabad, and Chilka Lake, Orissa. A bluewinged teal ringed by us at Pt. Calimere in South India was recovered in Kano, Nigeria.

ICAR Seminar on Economic Ornithology. The Seminar-cum-Workshop was organised between 21st and 25th May at the Society with financial support from the Indian Council of Agricultural Research. The participants were from Agricultural Universities in India. There were two visiting lecturers from the U.K. The theme of the seminar was ' Birds and Agriculture '. The Workshop dealt with methods of bird study.

Primate Research Centre, Japan. A research team from the Centre accompanied by one of the field staff of the Society surveyed the present status of the Rhesus Macaque in Central India and the distributional limits of the Rhesus and the Bonnet Macaques in the Peninsula.

Study of the Lion-tailed Macaque (Macaca silenus). The Society sponsored the application of Dr. Steven Green of the Rockefeller University, New York for studying the ecology and behaviour of the lion-tailed Macaque, an endangered species. An Indian graduate student was associated with him.

REFERENCE COLLECTIONS

During the year 497 specimens were received at the Society.

Mammals	13
Birds	331
Reptiles	114
Amphibians	39

Important additions to the collections are :

Birds : Brownwinged Kingfisher (*Pelargopsis amauroptera*)
Coll : J. C. Daniel & S. A. Hussain.
Loc : Bhitarkanika Island, Orissa.

Honeyguide (*Indicator xanthonotus*)
Coll : Sálim Ali.
Loc : Bhutan.

Goldheaded Blackfinch (*Pyrrhoplectes epauletta*)

Reptiles : Skinks : *Leiolopisma latrimaculatum*, *L. beddomei*, *L. palnicum*, *Ristella guentheri*

Snake : *Dendrelaphis grandioculis*
Coll : Romulus Whitaker
Loc : Western Ghats.

NATURE EDUCATION SCHEME

The activities of the Scheme were continued on a more modest scale than usual as the Nature Education Organiser Mr M. R. Raut went on leave preparatory to retirement. Mr Raut was responsible for the activities of the Scheme from its inception in 1948. Under his guidance the Scheme drew the attention of the school children of Bombay to the world of nature, through lectures, field trips, and a series of booklets on nature authored by Mr Raut.

LIBRARY

During the year 175 books were added to the Library, of which 17 were purchased, 130 donated, and 28 received as review copies for the *Journal*. The total number of books and bound periodicals in the library is 8532 and includes many rare and out-of-print volumes on Indian natural history.

GRANTS & DONATIONS

The Society acknowledges with gratitude the following grants received for specific purposes :

Rs. 3000—from the Dorabji Tata Trust for field work.

Rs. 4500—from Dr Sálim Ali as a donation to the Sálim Ali/Loke Wan Tho Ornithological Research Fund.

Rs. 1000—from the Fauna Preservation Society (London) for Leopard study.

Rs. 2500—from the Gaekwad of Baroda for the Charles McCann Field Work Fund.

Rs. 600—from Mr S. Chaudhuri for the Charles McCann Field Work Fund.

The equipment purchased from grants from the Smithsonian Research Foundation and the Yale School of Forestry including vehicles has been donated to the Society by these institutions.

Awards & Honours

Dr Sálim Ali was presented with the 'Ivanowsky Jubilee Medal' on behalf of the Scientific Committee of the Ivanowsky Institute of Virology, Moscow.

Dr Sálim Ali was made an Officer of the Golden Ark by H.R.H. The Prince of the Netherlands and a Member of Honour by the World Wildlife Fund in recognition of outstanding service to the conservation of wildlife and the natural environment. He was also awarded an honorary degree of Doctor of Science by Delhi University.

Meetings/Exhibitions

January : Dr Volmar spoke on 'Round the world in 60 slides'. Dr Karan Singh spoke on 'Wildlife Tourism'.

March : Cactus club show
Dr Madhav Gadgil spoke on 'Sacred Groves and ancient practices of Nature Conservation'.

April : Mr P. Merwanji spoke on 'Birds of Bharatpur'.

June : Mr J. C. Daniel spoke on 'Crocodiles of Bhitarkanika'.

July : Dr Sálim Ali spoke on 'Wildlife Tourism in Africa'. Mrs Malati Tambay-Vaidya spoke on 'Tourism in Maharashtra'.

September : Exhibition of 'Bird Paintings' by D. W. Sharma. Dr Juan Spillett spoke on 'Latest Techniques of Wildlife Management'.

December : Mr Orlando K. Cellucci spoke on 'The Asian Lion Project'. Mr David Fletcher spoke on 'East African Birds & Animals'. Mr Pat Louis showed slides on 'Natural History of India'. Mr E. Hanumantha Rao showed slides on 'Wildlife of India'.

Revenue and Accounts

The financial situation of the Society continued to be very difficult. The year's operation showed a deficit of Rs. 30,090.09 in spite of stringent economies.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the staff in the entire activities of the Society. Mr Madhav Raut, the Nature Education Organiser retired during the year (since deceased).

ACKNOWLEDGEMENTS

The Committee's thanks are due to Mr M. J. Dickins who looked after the Society's affairs in the U.K., and to the members and others who gave help in its field projects and other activities.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VIII [VIDE RULE 17(1)]

BALANCE SHEET FOR THE YEAR ENDED 31ST DECEMBER, 1973

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Trust Funds or Corpus :			*Immovable Properties :*		
Life Membership Fund :			*Motor Cars, Motor Cycle and Auto Cycle:*		
Balance as per last Balance Sheet ..	70,162·26		Balance as per last Balance Sheet ..	24,590·39	
Add : Amount received during the year	5,760·00	75,922·26	*Add :* Value of the cars and Motor cycle purchased during the earlier years and charged to different projects and grant accounts, now brought into books of accounts	32,753,92	
Fixed Assets Fund :				57,344.31	
Balance as per last Balance Sheet	60,680·08		*Less :* Depreciation during the year ..	11,468·86	45,875·45
Add : Value of fixed Assets purchased during the year and in earlier years and debited to various projects and grant accounts etc. now brought into books of accounts (as per contra) ..	86,738·79		*Furniture, Fixture and Equipment :*		
	1,47,418·87		Balance as per last Balance Sheet ..	35,989·69	
Less : Transferred to Income and Expenditure Account on account of Depreciation for the year ..	22,715·68	1,24,703·19	*Add :* Additions during the year (out of Government grant)	31,320·00	
General Reserve Fund :			*Add :* Value of furniture & equipment purchased during the earlier years and charged to different projects and grants account, now brought into books of accounts ..	22,664·87	
Balance as per last Balance Sheet ..		34,015·40		89,974·56	
			Less : Depreciation during the year ..	11,246·82	78,727·74
Carried forward ..		2,34,640.85	Carried forward ..		1,24,603.19

BALANCE SHEET FOR THE YEAR ENDED 31ST DECEMBER, 1973—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward ..		2,34,640·85
Building Fund: Balance as per last Balance Sheet ..		9,244·68
Publication Fund : Balance as per last Balance Sheet ..		30,725·00
Other Earmarked Funds : (As per Schedule 'A') ..		2,56,110·73
Provision for Capital Losses : Balance as per last Balance Sheet ..		4,528·38
Provision for Depreciation on Investments : Balance as per last Balance Sheet ..	6,801·25	
Add : Appropriated profit on sale of Investment ..	2,464·85	9,266·10
Carried forward ..		5,44,515·74

ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,24,603·19
Investments : Quoted— (At appropriate Cost) Sale proceeds of 12 ordinary shares in Ahamedabad Mfg. & Calico Printing Co. Ltd., of the value of Rs. 125 each fully paid up	4,464·00	
Add: Sale proceeds of 6/10 ordinary fraction coupon and 2/4 convertible Bond fraction coupon	97·70	
	4,561·70	
Less : Appropriated cost on conversion of shares in Bank of India Originally held .. 2,055·21		
Appropriated cost on conversion of 6/10 ordinary fraction coupon & 2/4 convertible fraction coupon .. 41·64	2,096·85	
	2,464·85	
Less : Profit on the above sale transferred to Provision for Depreciation on Investment fund ..	2,464·85	
50, 8% Convertible Bonds each of Rs. 100 of Ahmedabad Mfg. & Calico Printing Co. Ltd. fully paid ..	2,130·20	
202, 8% Redeemable Bonds of Rs. 116 of Ahmedabad Mfg. & Calico Printing Co. Ltd. fully paid ..	9,982·95	
Carried forward ..	12,113·15	1,24,603.19

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1973—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		5,44,515·74	Brought forward ..	12,113·15	1,24,603·19
Liabilities :			*Government Securities :* (At cost)		
For Expenses	70,101·46		3% Conversion Loan 1946/86 of the face value of Rs. 25,000. (Market value Rs. 15,000·00) ..	25,000·00	
,, Advance Subscriptions and other Advances	3,213·39		5½% Government of India Loan 2,000 of the face value of Rs. 2,000 (Market value Rs. 1,945) ..	2,000·00	
,, Sundry Credit Balances ..	25,245·27		*Unquoted :*	39,113·15	
,, Overdraft of Chartered Bank ..	12,029·17	1,10,589·29	12 Year National Defence Certificates of the face value of Rs. 3,000 ..	3,000·00	
			Deposit with :	42,113·15	
			M/s. Indian Dyestuff Industries Ltd., Bombay	1,25,000·00	1,67,113·15
			Loans :		
			(Unsecured, considered good)		
			Loan Scholarships ..	Nil	
			Other Loans (to staff) ..	450·00	450·00
			Advances :		
			To Trustees ..	—	
			,, Employees (for camp expenses).	4,751·03	
			,, Others ..	789.69	5,540·72
Carried forward ..		6,55,105·03	Carried forward ..		2,97,707·06

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER* 1973—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		6,55,105·03	Brought forward ..		2,97,707·06
			Stocks :		
			Publications	81,196·57	
			Process cost of publications ..	3,325·74	84,522·31
			Income Outstanding :		
			Rent	—	
			Interest Accrued	8,027·92	
			Income-tax (refundable for Assessment year 1972-73)	89·00	
			Other Income:		
			Supplies and Services	44,555·40	
			Government of Maharashtra (Grant for 1973-74) ..	45,764·00	
			Indian National Science Academy (Grant for 1973-74) ..	3,000·00	1,01,436·32
			Cash and Bank Balances :		
			(*a*) In Current Account with :		
			National & Grindlays Bank Ltd., Bombay ..	5,747·72	
			National & Grindlays Bank Ltd., London ..	16,356·42	
			National & Grindlays Bank Ltd., Bombay (in savings Bank Account) ..	332·54	
Carried forward ..		6,55,105·03	Carried forward ..	22,436·68	4,83,665·69

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1973—*(continued)*

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		6,55,105·03	Brought forward ..		4,83,665·69
Note :			*Cash and Bank Balances* : (Contd.)		
(1) The Membership Subscriptions are taken into account on cash basis.			Amount of B/F ..	22,436,68	
			(*b*) *In Fixed Deposit with :*		
			Bank of India, Bombay (consisting of Rs. 36,000 of Dr Sálim Ali/Loke Wan Tho Ornithological Research Fund and Rs. 3,000 for Col. Burton's Nature Conservation Fund) ..	39,000·00	
			Chartered Bank, Bombay (consisting of Rs. 12,000 of Charles, McCann Vertebrate Zoology Field Work Fund & Rs. 8,500 for Dr Sálim Ali/Loke Wan Tho Ornithological Research Fund ..	42,400·00	1,03,836·68
			Income and Expenditure Account :		
			Balance as per last Balance Sheet ..	37,512·57	
			Add : Deficit as per Income and Expenditure Account ..	30,090.09	67,602·66
Total ..		6,55,105·03	Total ..		6,55,105·03

(Sd.) G. V. Bedekar, *Chairman, Executive Committee,* Bombay Natural History Society.	(Sd.) Zafar Futehally, *Honorary Secretary,* Bombay Natural History Society.	(Sd.) J. D. Kapadia, *Honorary Treasurer,* Bombay Natural History Society.	As per our report annexed. (Sd.) Habib & Co., *Chartered Accountants.*

The above Balance Sheet to the best of our belief contains a true account of the funds and liabilities and property and assets of the trust as per our report annexed.

Bombay, 17*th August* 1974.

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 *DECEMBER*, 1973

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ refunded during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1973 (5 minus 8)* (9)
(1) Field Work Fund ..	87·64	3,000·00	..	3,087·64	500·00	..	500·00	2,587·64
(2) Staff Welfare Fund ..	3,220·69	..	..	3,220·69	1,200·00	..	1,200·00	2,020·69
(3) Dr Sálim Ali/Loke Wan Tho Ornithological Research Fund	1,65,636·52	4,500·00	..	1,70,136·52	..	..	..	1,70,136·52
(4) Col. Burton's Nature Conservation Fund ..	3,951·16	217·50 (interest)	..	4,168·66	1,147·01	..	1,147·01	3,021·65
(5) Grant from California Academy of Sciences for Herpetological Survey ..	640·47	..	..	640·47	344·30	..	344·30	296·17
(6) Charles McCann Vertebrate Zoology Field Work Fund	11,936·10	3,555·00 (including interest Rs. 455)	..	15,491·10	..	..	..	15,491·10
(7) Grant from Seth Purushottamdas Thakoredas and Divaliba Charitable Trust for the publication of Sri M. Krishnan's Ecological Survey of India..	8,541·86	..	..	8,541·86	2,210·42	..	2,210·42	6,331·44
(8) Grant from Smithsonian Institution for the Secretarial Assistance to Dr Sálim Ali on the Publication of the Birds of India and Pakistan in Ten Volumes ..	1,058·57	..	..	1,058·57	1,032·00	..	1,032·00	26·57
Carried forward ..	1,95,073·01	11,272·50	..	2,06,345·51	6,433·73	..	6,433·73	1,99,911·78

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ refunded during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1972 (5 minus 8)* (9)
Brought forward Rs. ..	1,95,073·01	11,272·50		2,06,345·51	6,433·73		6,433·73	1,99,911·78
(9) Grant from Smithsonian Institution for the Bird Migration Study project ..	5,031·27	..	..	5,031·27	3,675·06	..	3,675·06	1,356·21
(10) Grant from His Majesty King of Bhutan for the publication of 'Birds of Bhutan' by Dr Sálim Ali ..	10,678·83	..	..	10,678·83	4,865·44	..	4,865·44	5,813·39
(11) Grant from World Wildlife Fund for the Publication of a Booklet on Conservation..	3,024·58	..	..	3,024·58	..	..	..	3,024·58
(12) Grant from Fauna Preservation Society, London, for Leopard study Project ..	44·51	1,000·00	..	1,044·51	785·15	..	785·15	259·36
(13) Scholarship Fund under Dr Sálim Ali/Loke Wan Tho Ornithological Research Fund Investments ..	6,696·26	13,110·45	..	19,806·71	7,136·83	..	7,136·83	12,669·88
(14) *Grant from Government of Maharashtra :*								
(1) Grant for 1972-73 :								
(*a*) For Establishment Expenses ..	8,575·50	..	877·00	9,452·50	9,452·50	..	9,452·50	..
(*b*) For Building Maintenance ..	2,324·41	..	..	2,324·41	1,416.72 30·69*	877·00	2,324·41	..
Carried forward ..	2,31,448·37	25,382·95	877·00	2,57,708·32	33,796·12	877·00	34,673·12	2,23,035·20

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought forward Rs. ..	2,31,448·37	25,382·95	877·00	2,57,708·32	33,796·12	877·00	34,673·12	2,23,035·20
(2) Grant for the year 1973-74 :								
(*a*) For Establishment expenses ..	..	35,764·00	..	35,764·00	28,429·00	..	28,429·00	7,335·00
(*b*) For Building Maintenance ..	..	6,000·00	..	6,000·00	5,136.18	..	5,136·18	863·82
(15) Grant from Govt. of India for the purchase of (specimen) Steel Cabinets ..	37,428·86	..	..	37,428·86	31,320·00	..	31,320·00	6,108·86
(16) Dr. Sálim Ali's 75th Birthday Fund ..	12,585·76	10·00	..	12,595·76	..	..	..	12,595·76
(17) Grant, Government of India, Ministry of Agriculture for the scheme on Indian Migratory Bird Survey (Department of Agriculture) ..	..	50,000·00	..	50,000·00	43,827·91	..	43,827·91	6,172·09
Total ..	2,81,462·99	1,17,156·95	877·00	3,99,496·94	1,42,509·21	877·00	1,43,386·21	2,56,110·73

* The relevant amounts being unspent have been refunded to the Government Authorities.

As per our report of even date
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August*, 1974.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1973

EXPENDITURE	Rs. P.	Rs. P.	INCOME		Rs. P.	Rs. P.
To Expenses in respect of Properties :			*By Rent :*			
			Accrued		Nil	
Rates, Taxes & Cesses	Nil		Realised		Nil	Nil
Repairs and Maintenance ..	Nil		,, *Interest* (Accrued and Realised)			
Salaries	Nil					
Depreciation (by way of provision or adjustments)	Nil		On Securities ..	3,374·87		
		Nil	*Less:* Income-tax deducted at source ..	523·00	2,851·87	
,, *Building Maintenance Expenses* (as per contra) :			On Fixed Deposits ..	17,942·57		
Met out of Maharashtra Government grant for 1972-73 ..	1,416·72		*Less:* Income-tax deducted at source ..	1,126·00	16,816·57	
Met out of the Maharashtra Government grant for 1973-74 ..	5,136·18				19,668·44	
		6,552·90	*Less:* Transferred to respective funds		13,782·95	5,885.49
,, *Establishment Expenses :*			,, *Donations :*			
Salaries including D.A. (from Government of Maharashtra Grant (as per contra) ..	37,881·50		In cash		1,811·20	
Salaries including D.A. (other than above) ..	66,264·34		In kind (one nesting Godrej Chair from Cactus & Succulent Soc. & Two Binoculars from Members) ..		..	
Carried forward ..	1,04,145·84	6,552·90	Carried forward ..		1,811·20	5,885·49

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1973—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward	1,04,145·84	6,552·90	Brought forward	1,811·20	5,885·49
To Establishment Expenses : (contd.)			*By Towards specific funds :*		
Society's contribution to Staff Provident Fund	3,019·25		1. Field Work Fund	3,000·00	
Postages	3,095·25		2. Sálim Ali/Loke Want Tho Ornithological Research Fund	4,500·00	
Printing and Stationery	2,866·91		3. Charles McCann Vertebrate Zoology Field Work Fund	3,100·00	
Advertisements	104·80		4. Fauna Preservation Society, London for Leopard Survey project	1,000·00	
Telephone Charges	1,699·10		5. Dr. Sálim Ali's 75th Birth day fund	10·00	13,421·20
Bank Charges	597·90		,, *Grants :*		
Meeting Expenses	1,696·84		(a) *Government of Maharashtra :*		
Conveyance and Travelling Expenses	332·57		For 1973-74 Establishment Expenses	35,764·00	
Motor Car charges	1,639·27		For 1973-74 Building Maintenance	6,000·00	
Legal Fees	15·00		(b) *Government of India :* Ministry of Agriculture (Dept. of Agriculture) for scheme of Indian Migratory Bird Survey	50,000·00	
Staff Welfare Expenses (as per contra)	1,200·00	1,20,412·73	Educational Activity Grant 1973-74 Government of Maharashtra	4,000·00	
Audit Fees		1,000.00			
,, *Miscellaneous Expenses :*					
General Charges	578·40				
Insurance premium	169·95				
Repairs to Furniture and equipment	105·40				
Nārcondam Hornbill feeding expenses	417·74				
Transperencies Cataloguing expenses	500·00	1,771·49			
Carried forward		1,29,737·12	Carried forward	95,764·00	19,306·69

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1973—(continued)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward ..		1,29,737·12	Brought forward ..	95,764.00	19,306·69
To Amounts Written off :			*By Grants* : (contd.)		
(*a*) Bad Debts	30·07		*Government of India:*		
(*b*) Loan Scholarships	..		For Journal Publication Expenses for 1973-74	10,000·00	
(*c*) Irrecoverable Rent	..		,, *Indian National Science Academy:*		
(*d*) Other Items	47·52	77·59	For Journal Publication Expenses for 1973-74	3,000·00	1,08,764·00
,, *Depreciation :*			,, *Income from Other Sources :*		
On Furniture and Equipment ..	11,246·82		Membership Subscriptions ..	30,853·49	
On Motor Cars, Motor Cycle and Auto Cycle	11,468·86	22,715·68	Subscribers to Journal(Non-Members)	11,842·39	
,, *Transfer to Reserve or Specific Fund :* (As per contra)			Student Membership Subscriptions ..	320·00	
Grants transferred to relevant funds..	91,764·00		Entrance Fees	665·00	43,680·88
Donations towards specific funds transferred to releveant accounts in the Balance Sheet ..	11,610·00	1,03,374·00	,, *Publications :*		
,, *Expenditure on Objects of the Trust :*			Journal Sales (Back issues) ..	1,251·22	
(*a*) Religious	Nil		,, *Profit on Sale of Books :*		
(*b*) Educational—Journal Expenses	47,094·28		Book of Indian Birds	7,419·28	
—Journal Indexes..	2,618·00		Book of Indian Animals ..	10,026·38	
Bhutan Bird Survey Expenses	10,216·53		Identification of Poisonous Snakes charts	330·00	
From Respective Funds : (As per contra)			Picture Post-cards	377·50	
(*a*) Scholarship for field work (out of the Field Work Fund) ..	500·00		Other Publications	4,028·02	
			Nature Calendars	9,589·45	
				33,021·85	
			Less : Packing charges ..	316·90	32,704·95
Carried forward ..	60,428.81	2,55,904·39	Carried forward ..		2,04,456·52

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1973—(continued)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward ..	60,428.81	2,55,904.39	Brought forward ..		2,04,456.52
Expenditure on Objects of Trust: (contd.)			*By Miscellaneous Receipts :* (including Rs. 6,000 compensation from World Wild Life Fund, Regional Office India)		7,016·28
(*b*) Expenses on Nature conservation projects (out of Col. Burton's Nature Conservation Fund) ..	1,147·01		,, *Library Fines* (collected from Members)		99·30
(*c*) Expenses on Herpetological Survey (out of grant from California Academy of Sciences) ..	344·30		,, *Administrative Fees :* (For handling various projects, grants during the year, debited to the respective grants and funds) ..		3,045·42
(*d*) Expenses on publication of Shri M. Krishnan's book on Ecological survey of India (out of grant from Seth Purushottamdas Thakoredas Divaliba Charitable Trust)	2,210·42		Fees for the use of Society's transparencies		7,128·10
(*e*) Expenses relating to Secretarial Assistance to Dr. Sálim Ali for the publication of Birds of India and Pakistan in ten volumes (out of grant from Smithsonian Institution)	1,032·00		,, *Transfers :* Depreciation on Fixed Assets transferred to Fixed Assets Fund ..	22,715·68	
(*f*) Expenses Bird Migration Study Project (out of grant from Smithsonian Institution) ..	3,675·06		Expenditure towards research Scholarship and other exps. on Ornithological research transferred to Sálim Ali/Loke Wan Tho Ornithological Research Fund ..	7,136·83	
(*g*) Expenses on publication of Birds of Bhutan by Dr. Sálim Ali (out of grant from His Majesty King of Bhutan)	4,865·44		Expenditure on Establishment and Building Maintenance transferred to Govt. grant Accounts ..	44,434·40	
Carried forward ..	73,703·04	2,55,904,39	Carried forward ..	74,286·91	2,21,745·62

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER. 1973—(continued)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward ..	73,703.04	2,55,904·39	Brought forward ..	74,286·91	2,21,745·62
Expenditure on Objects of Trust: (contd.)			*Transfers :* (contd.)		
(*h*) Expenses on Leopard Survey project (out of the grant from Fauna Preservation Society, London)	785·15		Expenditure on Staff Welfare and Other Specific objects transferred to relevant Funds ..	59,587·29	
					1,33,874·20
(*i*) Expenses on Scheme of Indian Migratory Bird Survey (out of grant Govt. of India, Ministry of Agriculture (Department of Agriculture).	43,827·91		Excess of expenditure over Income transferred to Balance Sheet ..		30,090·09
(*j*) Expenditure towards Research Scholarship and other expenses on Ornithological Research (out of Sálim Ali/Loke Wan Tho Fund)	7,136·83				
		1,25,452·93			
Library Account :					
Subscriptions to other Societies ..	2,034·34				
Purchase of books	142·64				
Book-binding charges ..	1,027·00				
Other Library expenses ..	80·00				
		3,283·98			
,, Maintenance of Reference Collections		1,068·61			
Total ..		3,85,709·91	Total ..		3,85,709·91

As per our report annexed.
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August* 1974.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the Year ended 31 *December* 1973

RECEIPTS	Rs. P.	Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1973			By Salary of Nature Education Organiser		5,427·00
National & Grindlays Bank Ltd., Bombay, on Current Account ..		10,280·59	,, Printing and Stationery ..		853·16
			,, General Charges		1,316·81
,, Sales of Nature Study Booklets ..		148·49	,, Postages		220·65
,, Advance from Bombay Natural History Society ..		52·10	,, *Balance as at 31st December*, 1973		
			With Bombay Natural History Society		148·49
			With National & Grindlays Bank Ltd., Bombay, on Current Account ..		2,515·07
Total ..		10,481·18	Total ..		10,481·18

As per our report annexed.
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August*, 1974.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY 400023, ON FRIDAY, 20TH SEPTEMBER 1974, AT 6-30 P.M., WITH MR. G. V. BEDEKAR, I.C.S. (RETIRED), A VICE-PRESIDENT OF THE SOCIETY, IN THE CHAIR. THIRTY-ONE MEMBERS WERE PRESENT

1. At the suggestion of the President, Dr. Sálim Ali, Dr. A. N. D. Nanavati proposed and Dr. C. V. Kulkarni seconded that Mr. G. V. Bedekar, a Vice-President of the Society be elected the Chairman of the meeting. The proposal was accepted.

2. The Chairman advised the meeting that Mr. M. R. Raut, the former Nature Education Organiser of the Society who had retired in 1973 and Mr. S. Venugopal Rao, a member of the administrative staff had died during the year. The Chairman recorded the Society's deep appreciation of the work done by Mr. Raut and Mr. Rao. As a mark of respect to their memory the meeting observed a minute's silence, all members standing.

3. *Agenda Item* (1). With the consent of the members present, the reading of the Annual Report of the Executive Committee (copies of which had already been supplied to the members present) was dispensed with and the report was presented to the meeting. The Honorary Secretary said that he would be glad to answer any queries on the report. The Honorary Secretary clarified that he represented the Society on the Indian Board for Wildlife.

Mr. A. A. Dikshit raised the point that the total membership for 1973 as given in the Annual Report did not tally with the figures given in the Paymaster Sub-Committee Report. The Honorary Secretary explained that the figure given in the Annual Report was the actual figure of members, who had paid their subscription for the year as on 1st January 1974 and did not include those who had not paid but were still carried on the register in accordance with Rule 14 of the Society's Rules & regulations. The discrepancy was due to this factor. Dr. P. J. Deoras requested information on the conservation oriented research and field studies of the staff particularly with reference to Salt Water Crocodile Survey and the Leopard study. Information on these points was given by the Curator.

Mr. D. S. Manchekar desired details on the I.C.A.R. Seminar on Economic Ornithology and felt that information on the Seminar should have been sent to members, who wished to attend. He also stated that he wished to see papers that had been presented at the Seminar. The nature of the Seminar for which invitations were issued by the I.C.A.R. was explained and he was advised that he would be welcome to see manuscripts of such lectures as were available. The Annual Report was then adopted.

4. *Agenda Item* (2). The Chairman requested the Honorary Treasurer to present the Balance Sheet and Statement of Accounts for the calendar year 1973. Cyclostyled copies of these had been kept for member's perusal. Dr. R. N. Vasa wished to know whether the Committee had been aware of the receipt of funds from MAPS (Migratory Animal Pathological Survey) and drew attention to certain comments that had appeared. The Honorary Treasurer stated that the funds were received with the full knowledge of the Executive Committee and that the approval of the Government of India for the project proposal had also been received before the funds were made available to the Society.

Mr. H. Abdulali and Dr. P. J. Deoras objected to accommodation provided to the World Wildlife Fund—India at Hornbill House. The Honorary Secretary stated that their presence was on sufference and their association with the Society was to the Society's advantage. He cited two instances of co-operation benefiting both organisations (sale of 7,500 calendars by the World Wildlife, and sharing of proceeds from the sale of World Wildlife cards). Mention was made by Dr. A. K. Joshee and Mr. D. S. Manchekar that a verbatim report of the proceedings of the meeting was not being recorded since no stenographer was present. The Chairman observed that in accordance with usual practice the Honorary Secretary kept notes and drafted the minutes of the Annual General Meeting which were then seen by the Chairman of the meeting and placed before the Executive Committee for comments and thereafter published in the December issue of the Society's Journal. The Balance sheet and the accounts were adopted.

5. *Agenda Item* (3)-(A). The Chairman stated that the following nominations to the Executive Committee and the Advisory Committee were deemed to be approved :

President :
Dr. Sálim Ali, D.SC., F.N.A.

Vice-Presidents :
Mr. R. E. Hawkins
Mr. G. V. Bedekar, I.C.S. (Retd.)

Ex-Officio members of the Executive Committee

Advisory Committee :

Mr. H. G. Acharya	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Dr. B. Biswas	*Calcutta*
Mr. S. Chaudhuri	*Calcutta*
Dr. Chintaman Deshmukh, I.C.S. (Retd.)	*Hyderabad*
Mr. Zafar Futehally	*Bangalore*
Mr. Shivrajkumar Khachar	*Jasdan*
Mr. M. Krishnan	*Madras*
Mr. Duleep Matthai	*New Delhi*
Mr. Ranjit Sinh, I.A.S.	*New Delhi*

Executive Committee (*Ex-Officio* members) *:*

(1) Dr. A. N. D. Nanavati, M.D. (Honorary Secretary)
(2) Mr. J. D. Kapadia, I.C.S. (Retd.) (Hon. Treasurer)
(3) Secretary, Ministry of Education, Government of India

(B) As regards ten members of the Executive Committee, the Chairman stated that apart from the nominees of the outgoing Executive Committee, whose names have been shown in the agenda papers (and are reproduced here) three nominations have been received as shown below :

(i) Nominees of the Executive Committee :

(1) Mr. Humayun Abdulali
(2) Dr. S. R. Amladi, M.D.
(3) Prof. P. V. Bole
(4) Dr. E. B. Fanibunda, F.D.S.R.C.S. (Eng.), F.R.P.S.
(5) Mr. Bansi Metha
(6) Mr. D. J. Panday
(7) Mr. B. B. Paymaster, I.C.S. (Retd.)
(8) Mr. G. S. Ranganathan
(9) Mr. D. E. Reuben, I.C.S. (Retd.)
(10) Dr. C. V. Kulkarni, M.SC., Ph.D. (Jt. Hon. Secretary)

(ii) *Three other nominations :*

(1) Dr. P. J. Deoras — Proposed by Mr. A. A. Dikshit and seconded by Mr. B. F. Patuck.
(2) Mr. A. A. Dikshit — proposed by Mr. A. K. Joshee and seconded by Miss Kamala Srinivasan.
(3) Dr. R. N. Vasa — proposed by Mr. Sidney D'Souza and seconded by Mr. Boby Kovoor.

It would therefore be necessary to hold a postal ballot, as provided in Rules 32 and 33.

6. *Other business :* (a) The following resolution, of which notice had been given by Mr. S. R. Nayak was next considered by the meeting :

> 'Considering the fact that the Society has an All India and International membership and is largely recognised in India and Internationally as the premier organisation on Indian Natural History Society, it is resolved that the name of the Society be amended to Indian Natural History Society and the name of the Society's Journal be amended to Journal of Indian Natural History Society.'

The resolution was seconded by Dr. S. R. Amladi. It was stated that in view of the All India and International nature of the Society, the present name with its parochial implications prevented the Society from establishing branches in other parts of the country, and also that if an 'Indian Natural History Society' were to be started, such a society would receive all the previleges and standing of that name, which rightly belongs to the Bombay Natural History Society.

Mr. J. P. Irani and Mr. H. Abdulali opposed the proposal. Several members drew attention to the fact that a proposal of such significance should not be considered unless it had been previously circulated, and members given sufficient time to think and decide on the proposal. The Chairman drew attention to the fact such a proposal if carried would necessitate action in accordance with the provisions of the Society's Registration Act. After discussion, Mr. Nayak withdrew the resolution.

7. The second resolution, of which notice had been given by Mr. A. A. Dikshit was next moved as under :

> 'Resolved that the findings of the Enquiry Committee headed by Mr. B. B. Paymaster be duly published in the ensuing issue of the Journal of the Bombay Natural History Society.'

Dr. Deoras seconded the resolution. Mr. Dikshit stated that he felt that the Paymaster Report was very important and that all members of the Society should be aware of it and this would be best served by publishing the report in the Society's Journal which went to all members of the Society. Dr. P. J. Deoras, Dr. R. N. Vasa, Mr. D. S. Manchekar, Dr. A. K. Joshee and Miss K. Sreenivasan spoke in support of Mr. Dikshit's resolution.

The Honorary Secretary felt this was not practicable and offered to provide typed or cyclostyled copies to those who requested it. Mr Paymaster felt that the report not being a scientific document would be out of place in the journal, but he would agree if the proposal was for separate circulation. Mr. Abdulali suggested that it was not necessary to circulate the report to all the members of the Society, but only to those who wished to have a copy and offered to pay the cost of preparing cyclostyled copies for this purpose. Dr. S. R. Amladi and Dr. C. V. Kulkarni felt that the report was submitted to the Executive Committee at its request by its Sub-Committee and was essentially of an administrative character, and its publication in the scientific journal of the Society would not be appropriate.

The Honorary Secretary mentioned that the report apparently was not so important as some speakers made out, since only one member had taken the trouble to come and read it. A slip had been sent to all members with the notice of the Annual General Meeting that the report was available for perusal. After some further discussion the resolution was put to vote and was lost with 11 members voting for and 18 voting against.

The meeting terminated with a vote of thanks to the Chair.

In the postal ballot held in October 1974 the following were elected to the Executive Committee :

EXECUTIVE COMMITTEE

Mr. Humayun Abdulali
Dr. S. R. Amladi
Prof. P. V. Bole
Dr. P. J. Deoras
Dr. A. A. Dikshit
Dr. C. V. Kulkarni
Mr. D. J. Panday
Mr. B. B. Paymaster
Mr. G. S. Ranganathan
Mr. D. E. Reuben

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THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. 3rd (revised) edition. 28 plates in colour by Paul Barruel and many other monochrome illustrations. Rs. 40
(*Price to members Rs.* 35)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

Birds

The Book of Indian Birds, by Sálim Ali. 9th (revised) edition. 66 coloured and many monochrome plates. Rs. 35
(*Price to members Rs.* 30)

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(*Price to members Rs.* 2)

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4. OUR MONSOON PLANTS (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. Rs. 0·80
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Back numbers of the Society's Journal. Rates on application.

The Society will gratefully accept back numbers of the *Journal*, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Entrance Fees :		
Ordinary and Life Members	Rs.	25
Forest Department Nominees		—
Student Members	Rs.	10
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(*a*) Ordinary individual Members	Rs.	50
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(*c*) Ordinary Members resident outside India	£	3.50
(£ 3 plus 50 p. to cover extra postage on Journal)		
Life Members	Rs.	750
		(Rs. 250 after 20 years)
Compound Corporate Members	Rs.	1000
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Annual subscription to Journal	Rs.	90

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £3·50 should be paid annually to the Society's London Bankers—Grindlays Bank Ltd., 23 Fenchurch Street, London EC 3P 3 ED Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

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